EMPLOYMENT OF ESSA AND NIMBUS SATELLITE INFORMATION IN TROPICAL ANALYSIS AND FORECASTING

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by

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ABSTRACT

ESSA 2 and NIMBUS 2 APT daylight cloud photographs of the western Pacific area (0-20N, 135-165E) from 13 through 30 May 1966 were manually converted into digitized cloud charts indicating cover and type. The charts were superimposed on operational surface and 250-mb analyses and used in combination with 24-hour isallobaric/isalloneph charts to revise the analyses to reflect satellite observations. The map series indicated the relationship of synoptic-scale cloud systems, primarily in and near the Equatorial Trough region of the Western Pacific, with low level pressure fields and upper level lateral divergence zones. The cloud systems tied to Equatorial Trough phenomena were found to be trackable from day to day. Rainfall appeared to correlate well with the cloud charts and, as a test, cloud and precipitation forecasts were made and verified for selected stations.

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TABLES AND ILLUSTRATIONS

SECTION I. Introduction

It has long been recognized that accurate and detailed lower and upper tropospheric analyses over the tropical ocean areas of the world have suffered due to an inadequate number of regularly-reporting observation stations. The current situation is aptly stated in (1).

In view of this situation, the subject research was aimed toward utilizing weather satellite information as an analysis aid in an operationally important sparse data area. Specifically, the hypotheses of this experiment are that the weather satellite daylight photographs can be used to:

1. augment, clarify and increase the detail of both low level and upper level analyses of the tropical wind and pressure field, and,

2. show that a tropical cloud system, with less organization than that associated with depressions or disturbances, can be tracked from day to day and lead to improved weather forecasts.

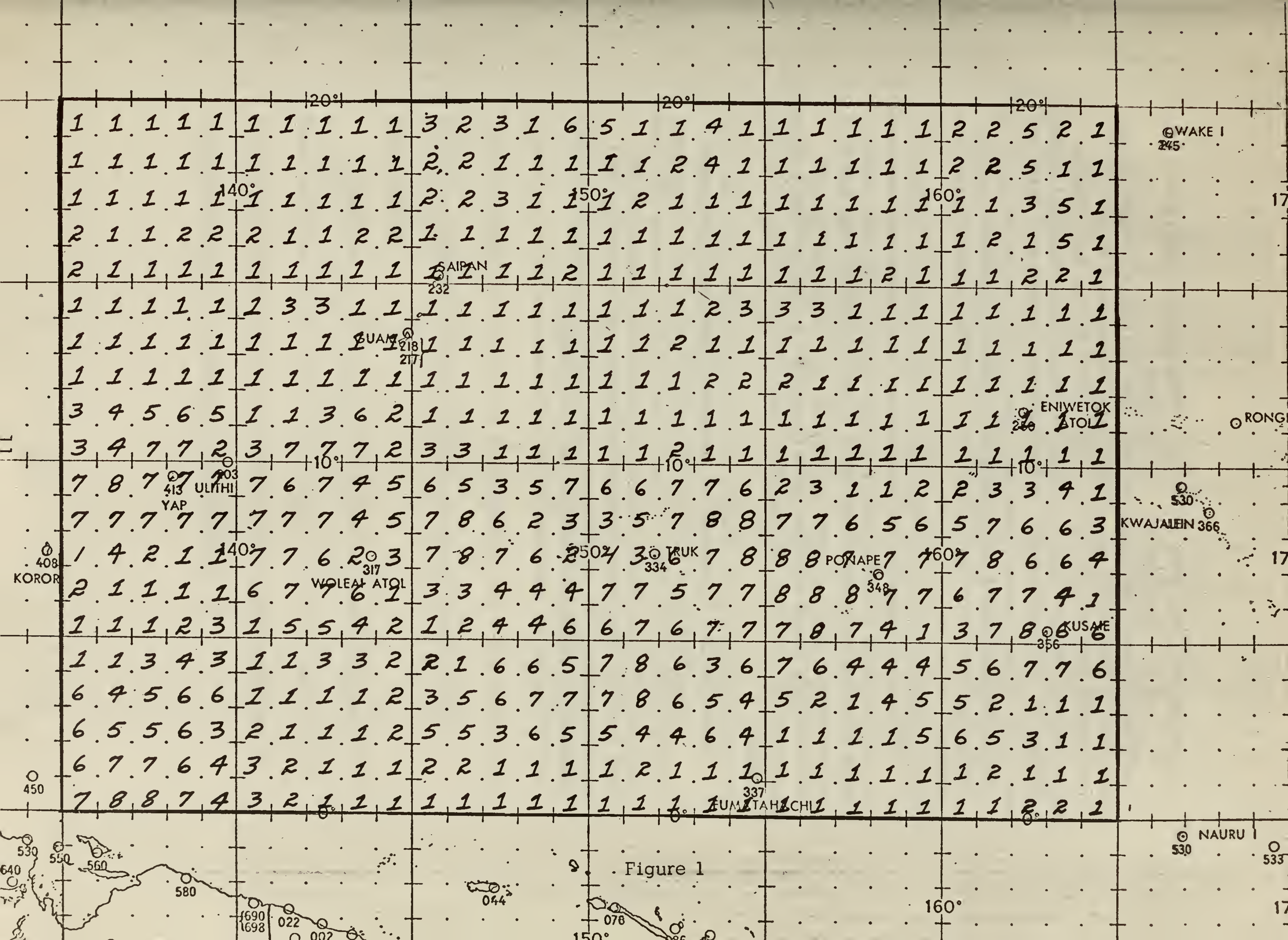
A further objective of this study is to supply the Department of Meteorology and Oceanography, United States Naval Postgraduate School, Monterey, California, with an updated tropical weather map series which utilizes recent operational weather satellite observations.

SECTION II. Data and Area of Study

The weather satellites in the Tiros Operational System (TOS) are called Environmental Survey Satellites (ESSA). In May 1966, there were two basic types of ESSA satellites. One type, ESSA 1, is equipped with a camera system that can be readout only by the Command and Data Acquisition (CDA) stations at Gilmore Creek, Alaska, and Wallops Island, Virginia. The other, ESSA 2, is equipped with a so-called Automatic Picture Transmission (APT) camera system which can be readout by any station possessing the appropriate receiver. Also in operation during May was an APT-equipped Nimbus 2 research and development satellite.

A restricted area within the zone of responsibility of the United States Navy Fleet Weather Central, Guam (FWCG), was selected for the study as may be seen in figure 1.

Daylight APT pictures from ESSA 2 and Nimbus 2 for the period 12 May through 31 May 1966 were obtained from FWCG. ESSA 1 nephanalyses for the same period were received through the Naval Air Systems Command, Project Fleet Applications of Meteorological Observations from Satellites (FAMOS), Suitland, Maryland. Conventional data and analyses for the same period were obtained from FWCG, United States Navy Fleet Weather Central, Pearl Harbor, and from the United States Navy Representative, National Weather Records Center, Asheville, North Carolina.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140°
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Figure 1

In general, two ESSA 2 passes of three pictures each were available for each day in the period. The total area covered by the two passes (45N to 25S, 125E to 175E) exceeded the area studied (figure 1). The average time of the easternmost pass was 2140Z and that of the subsequent pass 2340Z for a mean daily picture time of 2240Z.

ESSA 1 nephanalyses for several hours later were used each day as a gross check on the cloud cover in the experiment area and as a compatibility check on cloud types identified in earlier ESSA 2 photographs.

Some Nimbus 2 photographs, available each day a few hours after the ESSA 2 pictures, were used only as an aid in sun glint areas. They were not used more extensively because of the time lag and difference in resolution between the two systems.

SECTION III. Procedures

The cloud photographs were gridded into increments of area, one degree latitude by one degree longitude. Next, the APT pictures were manually digitized into a cloud cover code for each increment by using a scheme as shown in Table 1 (2). This coded value was then plotted on a chart of the same scale as that used for the conventional analyses at 0000Z each day. An example of a coded chart is shown in figure 1.

The 250-mb level was selected as representative of upper tropospheric conditions in the tropics. Streamline charts at this level were analyzed using radiosonde data and aircraft reports from military and commercial sources at altitudes from 30,000 to 40,000 feet.

Surface charts were analyzed for sea-level pressure at 0.5 mb interval and were considered as representative of lower tropospheric conditions. 850-mb streamline charts were used as an aid for the surface analyses. The surface and digitized cloud charts were used further to generate 24-hour pressure and cloud change charts, respectively.

Time sections for Guam and Truk were prepared (Appendix II). They were used as an aid in locating upper and lower tropospheric troughs and ridges and as a part of the conventional data used in making forecasts for certain stations (Appendix I).

SECTION IV. General Conclusions

This section synopsizes the general conclusions drawn from the analysis study. More detailed information which lead to these conclusions is found in the discussion of the daily charts (Appendix I).

It is pertinent at this point to show some climatological features of the experiment area. They are the May position of the Intertropical Convergence Zone (ITC) and associated flow pattern (figure 2), (3) and the subtropical anticyclonic vortex and a portion of the Mid-Pacific upper tropospheric trough found on the mean 200-mb streamline charts for May (figure 3) (4). Figure 3a was typical of the flow pattern early in the period investigated while that of late in the period was characterized by figure 3b. The streamline pattern for the middle of the period appeared transitional between the figures 3a and 3b.

Intertropical Convergence Zone—Mean position for May

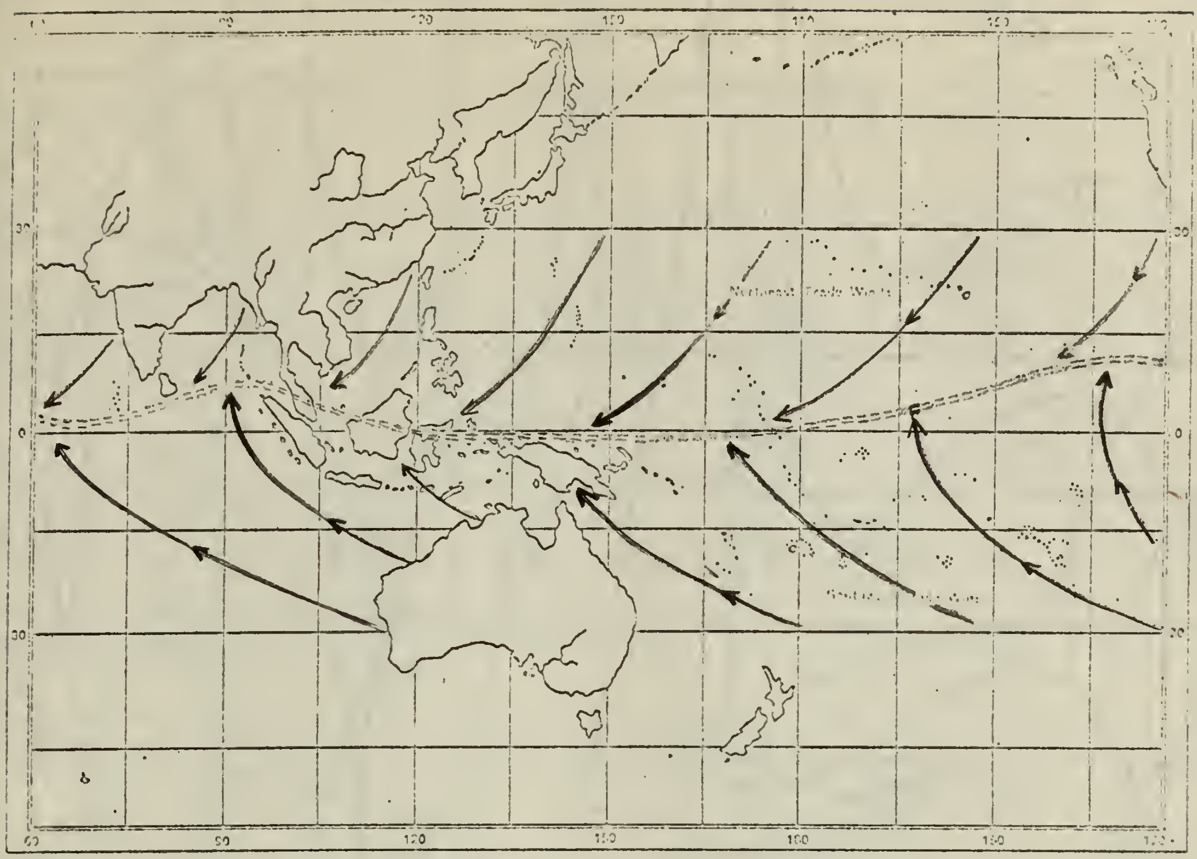
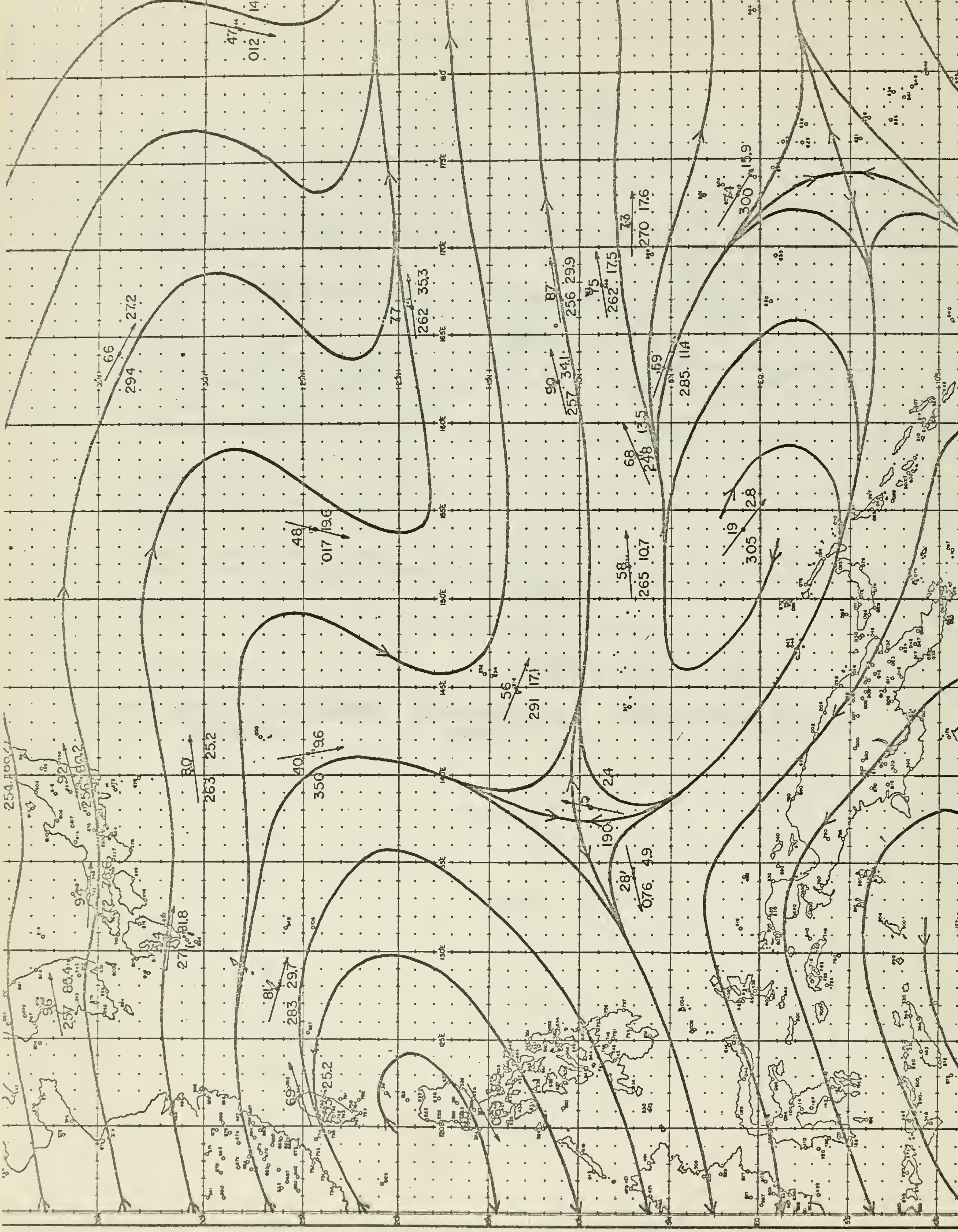
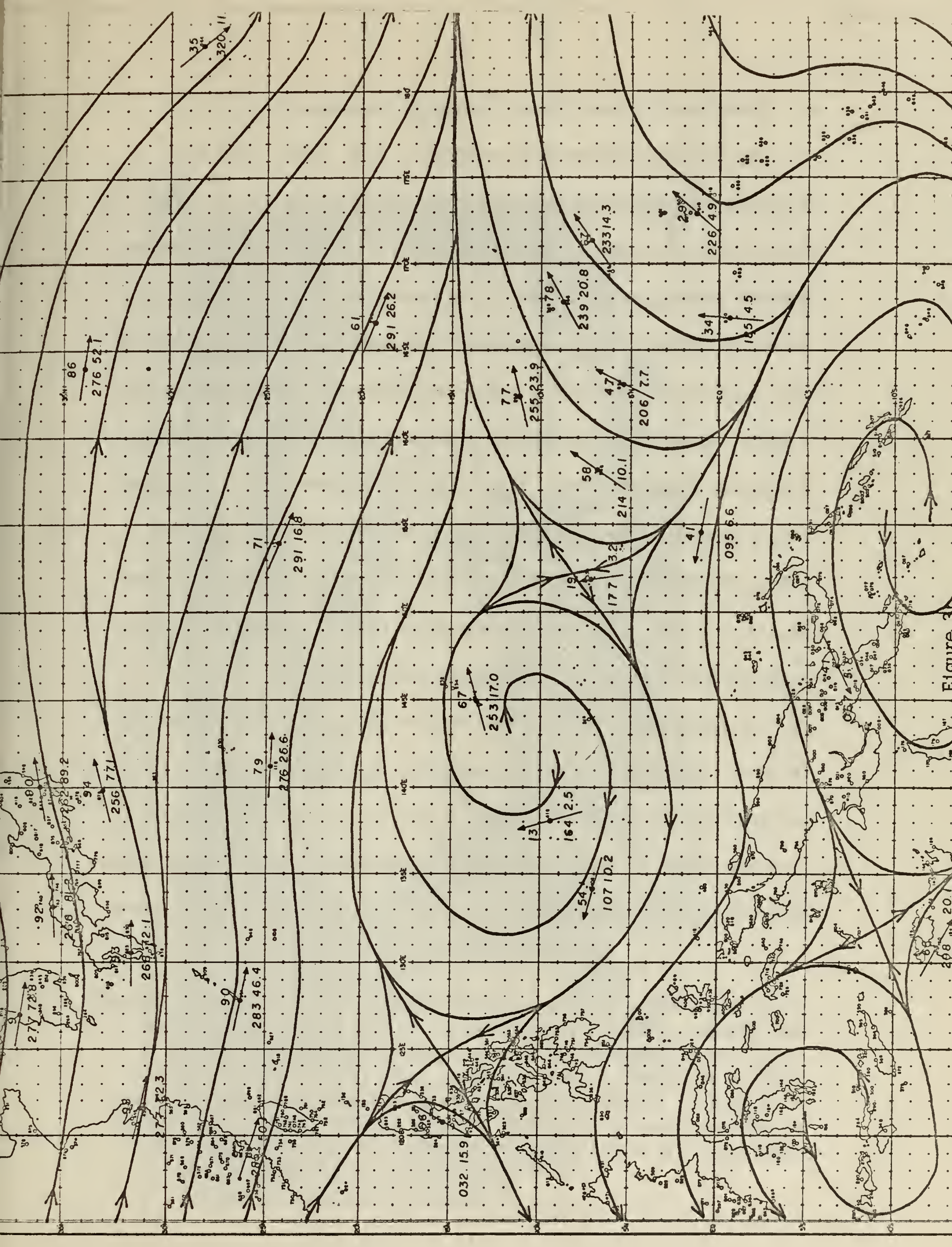


Figure 2

TABLE I

CLOUD COVER CODE	NEPHANALYSIS SYMBOL	APPROXIMATE CLOUD COVER IN TENTHS
1	0 or Clear	0 - 1
2		2
3	M O P	3
4		4
5	M C O	6
6		8
7	⊖	10
8	Disturbed	10





A. Satellite-Observed Clouds versus Precipitation.

The surface observations for Woleai, Yap, Guam, Truk and Eniwetok were compared with the coded cloud charts for the same time period. It became evident that there was a significant relation between certain coded values on the cloud chart and convective shower activity. Code 5 correlated very well with the occurrence of light showers while codes 4 and below did not, in general, coincide with any shower activity except in the case of cloud lines which are discussed separately later. Also code 6 and above usually occurred with a greater frequency of showers and correlated very well with heavy shower activity. The above can be seen by comparing figures 12, 14, 17, 20, 23, etc., with the daily rainfall statistics listed in Appendix III for each of the above named stations.

An explanation for the above relation can be seen by looking at figure 4. The subject cloud mass[1] was the most frequent and widespread cloud found in this study. It was composed of clusters of cumulus clouds in different stages of development with apparent middle cloud sheets between the cumulus towers, most of which had a cirrus

[1]A cloud mass by definition (5) is a large-scale area of reflection from clouds, with covered conditions. A cloud band is a synoptic scale, solid, covered, or mostly covered cloud pattern that has a width of at least one degree latitude and a length-to-width ratio of at least 4:1. In this paper cloud mass will refer to either cloud mass as defined above and/or cloud band. To further clarify the usage of cloud mass, it is designated as type one (see Table 2, page 40).

Figure 4

canopy. The cloud mass had distinct edges and only infrequently did middle or high cloud streamers extend from the cloud mass proper. This gave evidence that only small wind-vector shears existed between low and high cloud decks. Stations/ships as close as 60 nautical miles to the cloud mass reported little or no clouds. When the cloud mass moved over a station, it was preceded by little or no increase in high and middle clouds and the commencement of showers was coincident with the arrival of the cloud mass (see Appendix I). When the cloud mass was over a station on two successive photographs (24-hour interval) approximately a half inch of rain was received (Appendix I discussion for 14/00Z). Hence, there appeared to be a definite relationship between the horizontal and vertical extent of the cloud mass as borne out by the occurrence and magnitude of rainfall.

When cirrus blowoff from the cloud mass took place, e.g., figures 16 and 19, then in the area covered by the cirrus the above comments were not applicable. However, the areas covered by the cirrus blowoff were quite easy to distinguish and, in general, covered only a distance of 40 to 80 nm downstream of the cloud mass. Cirrus clouds, in a layer or streaks, probably extended further downstream but were not photographed by ESSA I due to their small vertical dimension. In one rare case cirrus clouds accounted for most of the overcast in the area denoted in figure 13.

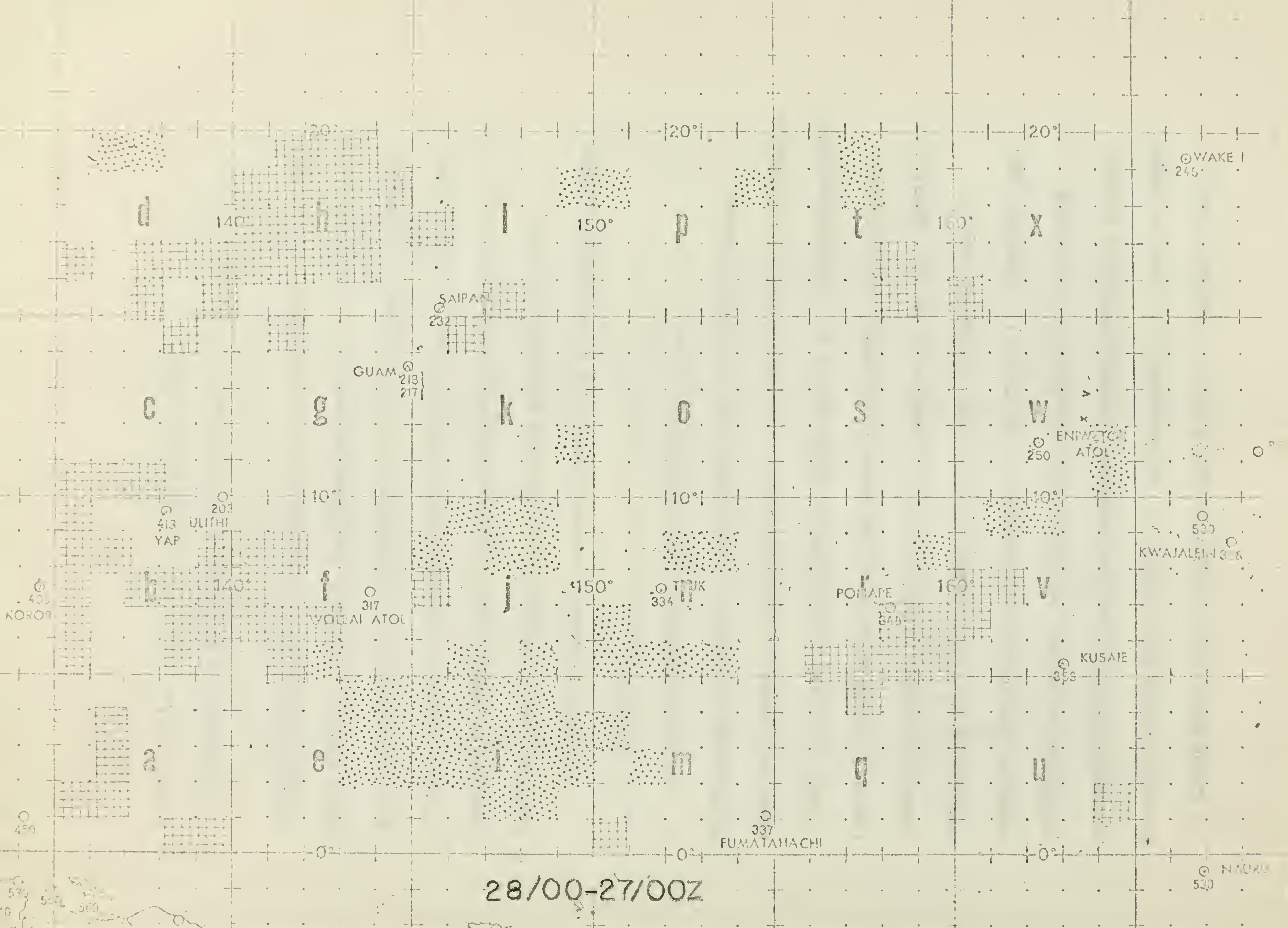
Cloud lines are, by definition (5), a series of aligned cloud elements, nearly all of which are connected and less than one degree latitude in width. Such lines generally were not considered in this experiment since they appeared rather infrequently and were not trackable (see examples in figures 23, 26, 29, 41). Moreover, they appeared to have little association with the weather at surface observation points except in one case (figures 23 and 26). This cloud line was very persistent and the rainfall at Eniwetok from 17/00Z to 18/00Z, as listed in Appendix III, resulted from it. At times, the cloud lines gave evidence of separating flow from two differing wind regimes, as indicated in figure 26. This aspect was not pursued further.

B. Satellite-Observed Clouds with regard to the:

1. Surface

Most cloud masses were associated with a perturbation[1] in the pressure field. Sometimes a cloud mass affiliated with one perturbation would merge with the cloud mass associated with another. However, it was usually possible to determine the cloud mass associated with each system by use of a 24-hour isalloneph chart (figure 5) and/or by noting the narrowing of, or break areas in, the cloud charts, code 5 and greater. These charts are superimposed

[1]Perturbation as used in this paper includes cyclones and/or troughs at low and/or high tropospheric levels.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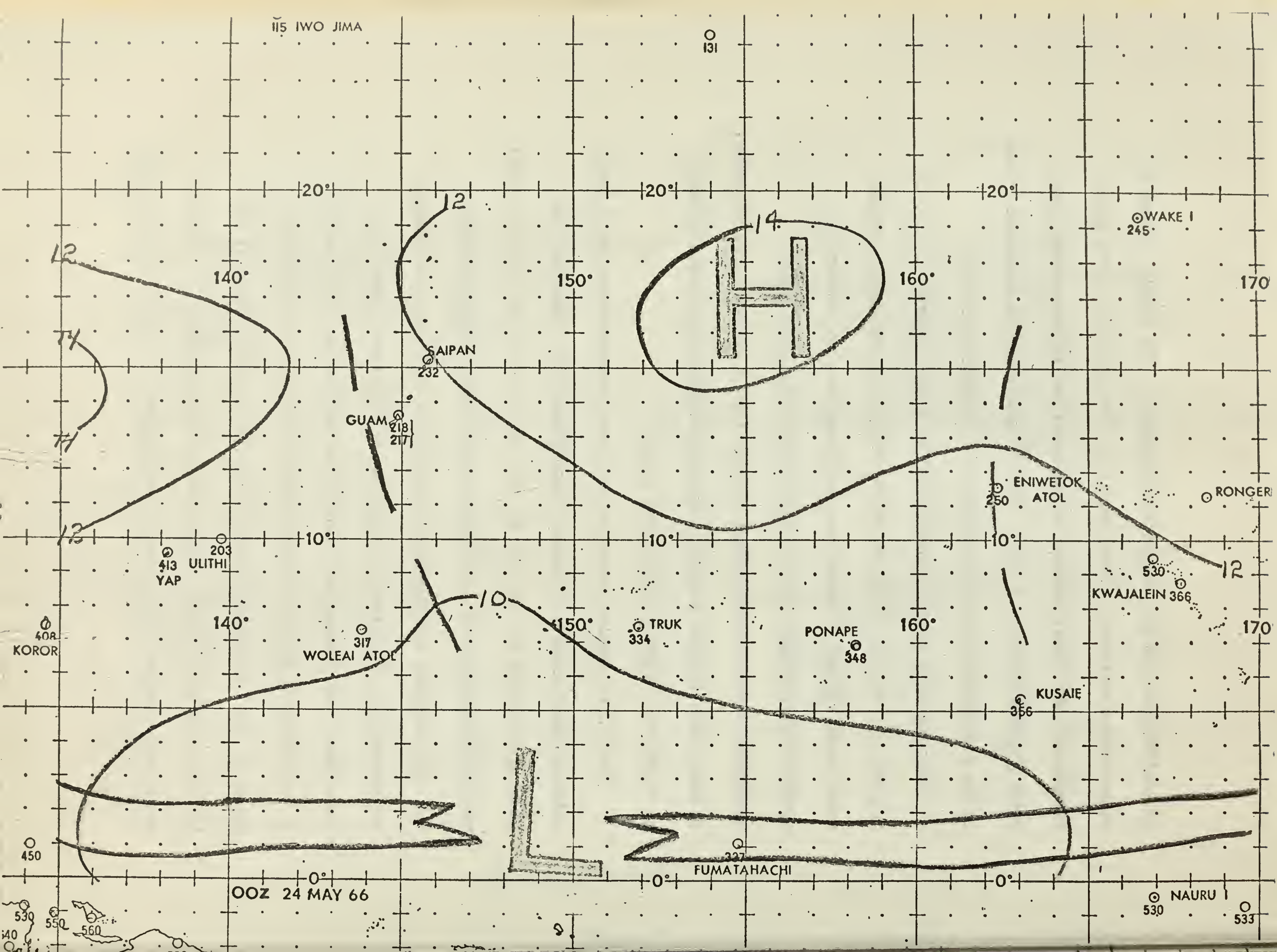
28/00-27/00Z

Figure 5

on surface and 250-mb analyses (Appendix I). The breaks, areas of cloud code 4 and less, varied greatly in size and some were quite extensive. Not every surface perturbation had an associated cloud mass (figures 26, 41, 44, 53). This situation will be explained by use of the 250-mb analyses as detailed in a subsequent section.

An extensive trough oriented north to south, figures 12, 14, 26, 50, 53, 56, 59, 63, could not be equated to the classical easterly wave model (6, chpt 9) since the cloud mass was not found to be extended meridionally on the upwind side of the perturbation. Generally, the extensive trough resulted from a frontally induced trough or some other surface pressure disturbance which had linked up with an equatorial easterly wave to the south.

The ITC is usually drawn on operational surface charts as a long unbroken band along a pressure trough (figure 6a). However, by looking at figures 12, 14, 20, 23, 26, 32, 35, 38, 62, it was evident that the cloud mass was not located only along such perturbations but also extended into regions of anticyclonic flow and was often discontinuous. That this is consistent with Palmer's models of convergence and divergence regions for a perturbation superimposed on a convergent or non-divergent basic current may be seen in (6, chpts 9, 10). It is suggested that the ITC be made identical with the cloud regions of code 5 and greater and be indicated as shaded zones on a surface or low level chart (figures 12, 14, 17, 20, 23, etc).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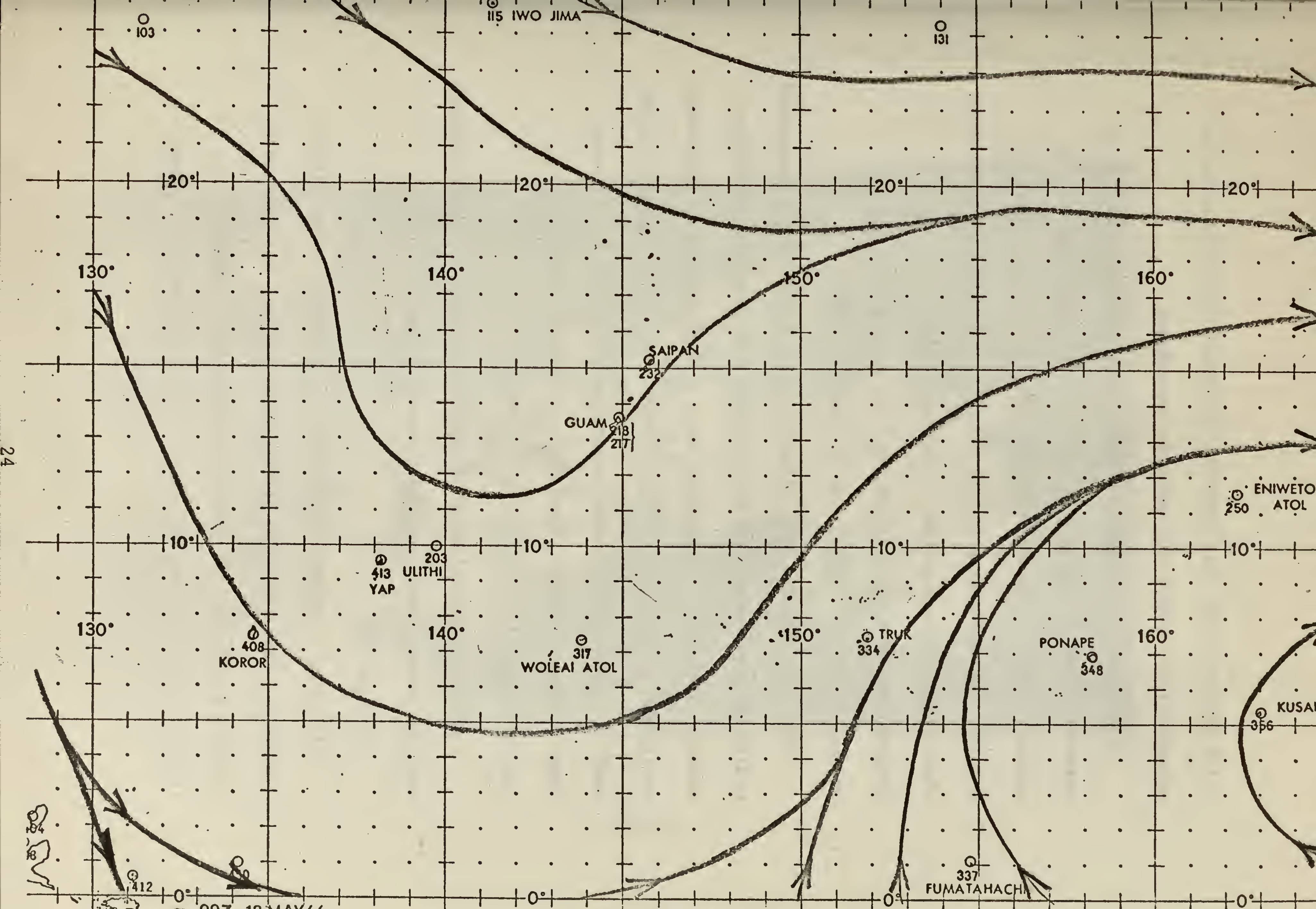

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Figure 6b

In the author's view, this analytical definition of the ITC leads to a meaningful and objectively locatable phenomenon.

With reference to Palmer's models, an outstanding example of observation versus theory for the convergent case can be seen by comparing figure 7 and figure 23 with figure 8 (see also figures 26 and 32). The non-divergent case of Palmer is exemplified in the area where suppressed convection is suggested ahead of the moving perturbation and a rather narrow zone of convergence to its rear (figures 12, 14, 20, 29, 35, 38, 50, 53, 56, 59).

Generally, a cloud mass associated with a perturbation diminished in size and the pressures in the trough or at the low center increased when the system moved rapidly or south of west (Appendix I discussion for 15/00Z, 16/00Z, 23/00Z). In several pressure systems that moved north of west the cloud mass contracted slightly in size but became better organized about the perturbation (Appendix 1 discussion for 18/00Z, 21/00Z, 22/00Z, 26/00Z, 27/00Z).

A possible explanation for these two relationships will be delayed until the 250-mb streamline charts are discussed.

2. Upper Air

At 250-mb a tropical anticyclonic vortex and/or lateral velocity divergence, with or without a divergent asymptote, was found to be coincident with the cloud mass for the most part (figures 11, 13, 16, 19, 22, 25, 28, 31, 34, 49, 52, 55, 58), as suggested by Palmer

Figure 7

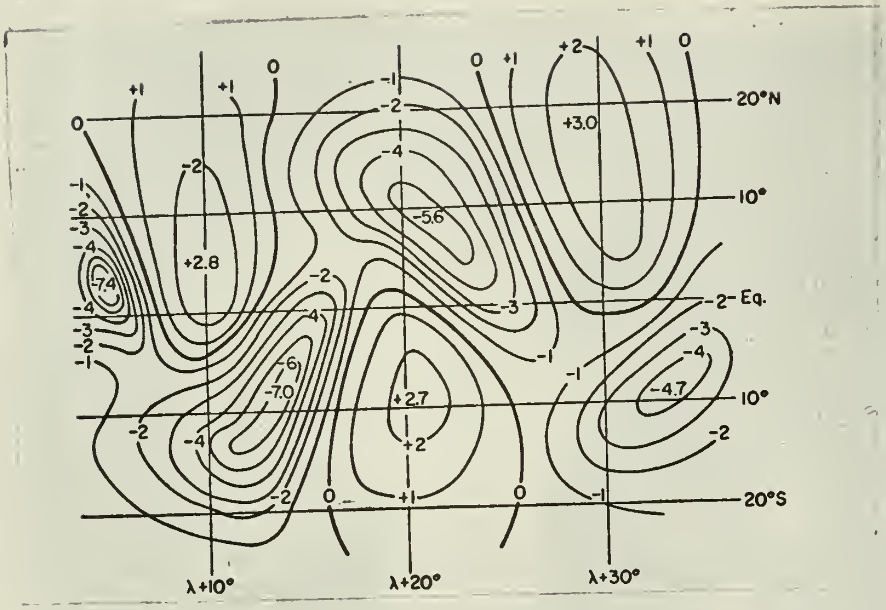

Figure 8

even as early as the 1950's. However, not every divergent asymptote had a cloud mass associated with it although these areas were prone to development of a cloud mass on subsequent days, e.g., compare figures 19, 25, 28, 46, 49 to those for the following day. Neutral points were usually found near the edge of the cloud mass (figures 11, 13, 16, 22, 25, 28, 31, 40, 43, 46, 49, 52, 55, 58, 61) while cyclonic vortices and lateral convergent areas were generally free of a cloud mass (figures 11, 13, 16, 22, 25, 31, 34, 40, 49, 52). The area near and at the subtropical high center also was usually void of a cloud mass (figures 34, 37, 40, 43, 46, 49) except in figures 11, 43, 55, where its divergent asymptote was associated with the cloud mass.

This divergent asymptote usually occurred where the subtropical high ridged extensively southward. In several instances, in this area, a tropical anticyclonic eddy broke off from the subtropical high (figures 9, 13, 43, and 46. Appendix 1 discussions for 15/00Z and 25/00Z). A tropical anticyclonic vortex was also generated several times in an area ahead of a progressive extended trough in the westerlies where some lateral divergence of the streamlines was in evidence (figures 9, 13, 16, 22, 25, 28, Appendix I, discussions of 15/00Z, 18/00Z, 19/00Z). Such lateral divergence generally occurred in an area where the flow was associated with a tropical anticyclonic vortex that had moved from the Northern to the Southern Hemisphere (figure 25). A critical temperature of $-39^{\circ}C$ or warmer was noted in the area where these tropical anticyclonic vortices formed. The tropical anticyclonic vortices generally travelled toward the south or southeast in the western portion of the area and toward the east or east northeast in the eastern portion of the area (figure 9). This was probably due to the influence of the Mid-Pacific upper tropospheric trough (figures 3a and 3b).

Cyclonic vortices were generated several times at the southern tip of an extended trough in the westerlies which had penetrated southward to near the equator (figures 34, 37, 43, 46, 49, Appendix I, discussions for 22/00Z, 25/00Z, 26/00Z). These vortices were cold core phenomena and generally travelled between west and northeast (figure 9). In most cases cloud masses were not associated with them (figures 13, 16, 19, 25, 37, 40, 46, 49, 52, 61).

Also at 250-mb the wind direction was found to coincide very well with cirrus blowoff (figures 11, 13, 16, 19, 22, 25, 31, 49) (7).

That a careful research analysis which utilized cloud photographs may lead to a more detailed version of tropical weather systems may be witnessed by comparing figures 6a and 6b,which show typical operational analyses, to the revised analyses (figures 44 and 25). It should be made clear that the aim here is to suggest the additional meteorological detail inherently gained in the co-consideration of the

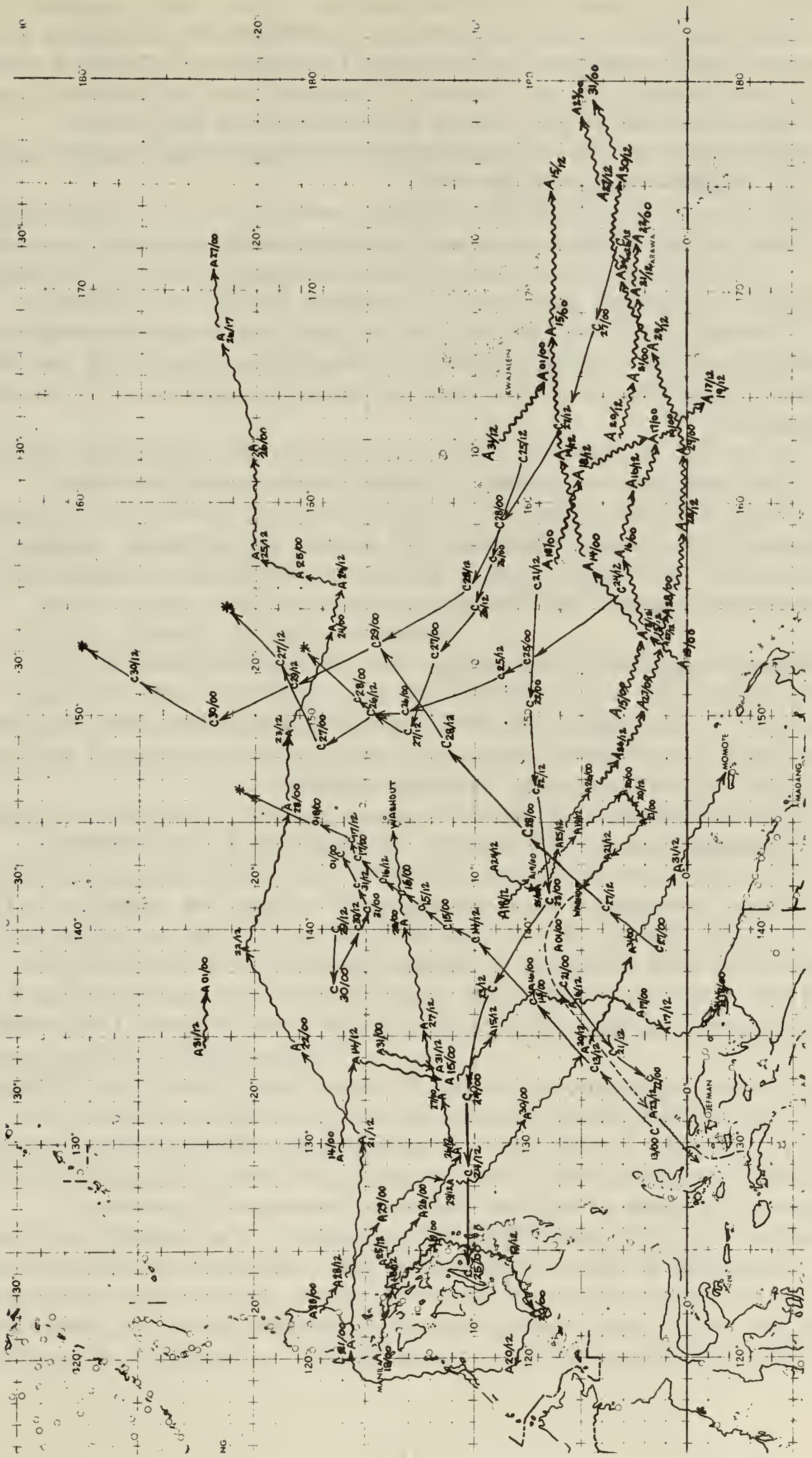

Figure 9

satellite with the conventional information. This study was not directed toward analyzing deficiencies in operational products which (by their very nature) are under a crucial time and data strain.

3. Surface versus Upper Air

The bulk of a cloud mass was found primarily wherever and whenever an anticyclonic vortex or its divergent asymptote aloft were superimposed on a surface pressure perturbation (figures 49 and 50, 52 and 53).

The cloud mass appeared to expand and contract in direct relation to the distance between the surface perturbation, moving generally westward, and the tropical anticyclonic vortex or its divergent asymptote, propagating east to southeastward on the average. It is realized that these geographical movements may be peculiar only to this month or period studied.

C. Satellite-Observed Clouds in the Realm of a Time Interval.

There has always been some question about the variation in the cloud mass with a change in surface pressure in a time interval. To find out what, if any, relationship exists, the 24-hour isalloneph charts were superimposed on the 24-hour isallobaric charts (figures 15, 18, 21, etc.). Note that, in general, the cloud masses increase/decrease in areas of relative decrease/increase of pressure.

When the 24-hour cloud-change-chart was used in conjunction with the cloud-code-5-and-greater-chart for the time at the beginning of the period it was possible to account for most of the significant cloud changes that had occurred. It was found by repeated use of this procedure (Appendix I) that the changes were due to the cloud mass found at the earlier time period translating and/or expanding or shrinking. Rather infrequently the changes were caused by a development of the cloud mass, in situ, (which could be detected because of the minimized diurnal effects), in the 24-hour time interval involved (Appendix I discussion for 16/00Z and others). In a few instances the changes resulted from a cloud mass that had moved and/or expanded northward across the equator (Appendix I discussion for 19/00Z, 20/00Z, 21/00Z and others).

Once the cloud changes were accounted for and the proper cloud mass and associated perturbation relationship established, then the cloud mass speed and direction were obtained by overlaying the cloud-code 5-and greater chart for one day on top of the same type chart for the following day. An example of this can be seen by noting that the same cloud mass in blocks s and w at 15/00Z had moved into blocks o and s by 16/00Z (figure 10).

The cloud mass generally moved with the speed and in the direction of the perturbation connected with it but there were notable exceptions (Appendix I, discussion for 14/00Z and others). Examples of forecasts based solely on extrapolated cloud mass velocities are discussed in Appendix I. Such forecasts can be compared to those

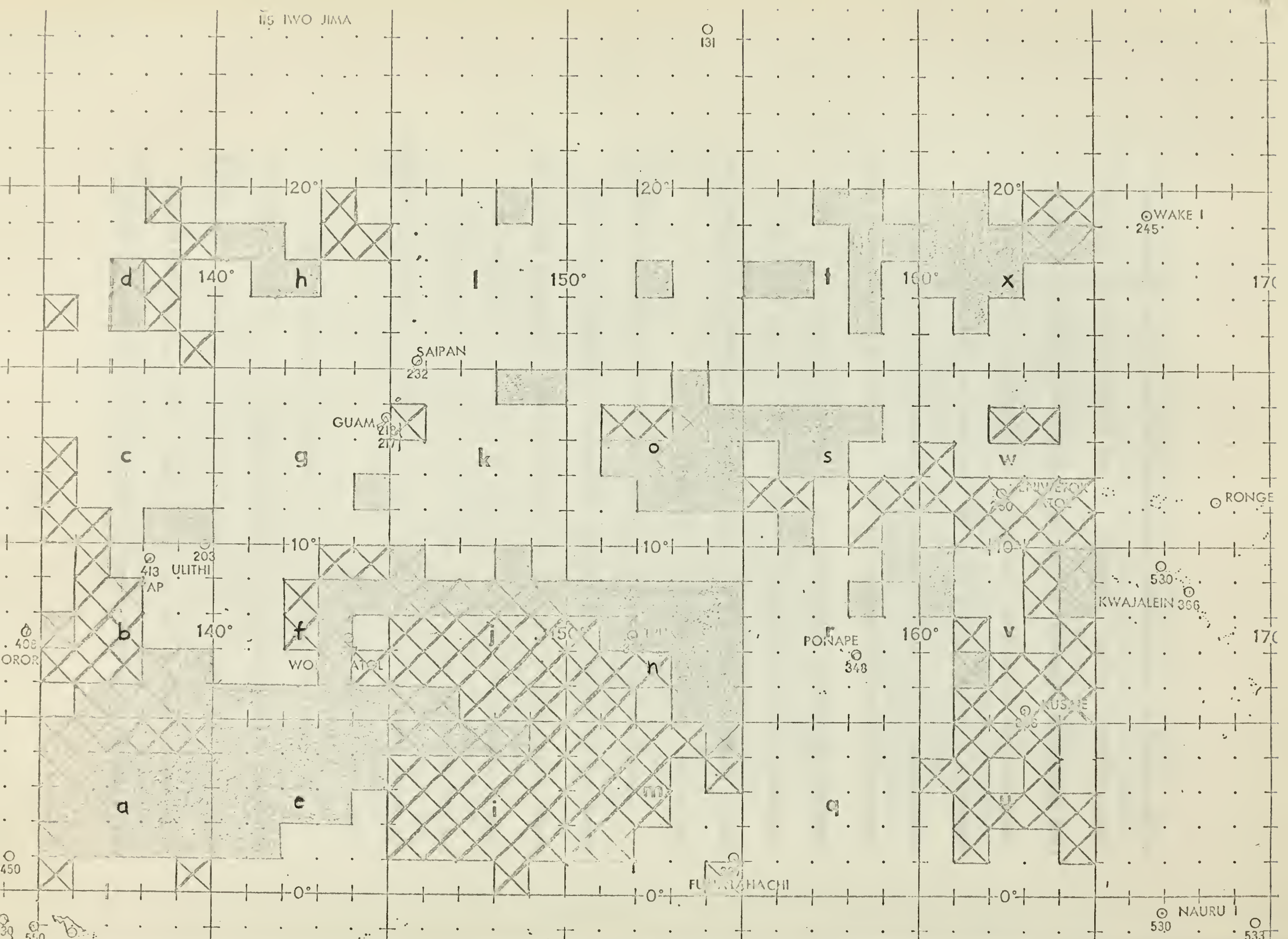
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Figure 10

using conventional data (taken from time section analysis). Such a comparison takes on significance from the standpoint of single-station forecasting in silent areas where only locally observed quantities are used. Radiosonde and APT satellite data both fall into this category.

It was tried, but without a great deal of success, to isolate areas that had consistent increases (sources) or decreases (sinks) of cloud mass due to development.

APPENDIX I. Discussion of the Daily Maps

This section is devoted to summarizing the highlights of the low and high level synoptic situations on the days comprising the study. It is hoped that the following exposition will be helpful when adapting the map series to exercises in the synoptic laboratory at the U. S. Naval Postgraduate School. Also "practice" cloud and precipitation forecasts were made each day for the ensuing 24-hour period for selected stations based solely on the extrapolated cloud mass velocity. Sample forecasts are outlined for most days.

00Z 13 May 1966 (figures 11, 12)

This is the base day of the study. The initial charts used in this study were analyzed using a history buildup that began with maps on the 12th. Due to this fact and the rapidly changing synoptic situation on the 14th, it became more logical to begin the discussions with the 14th.

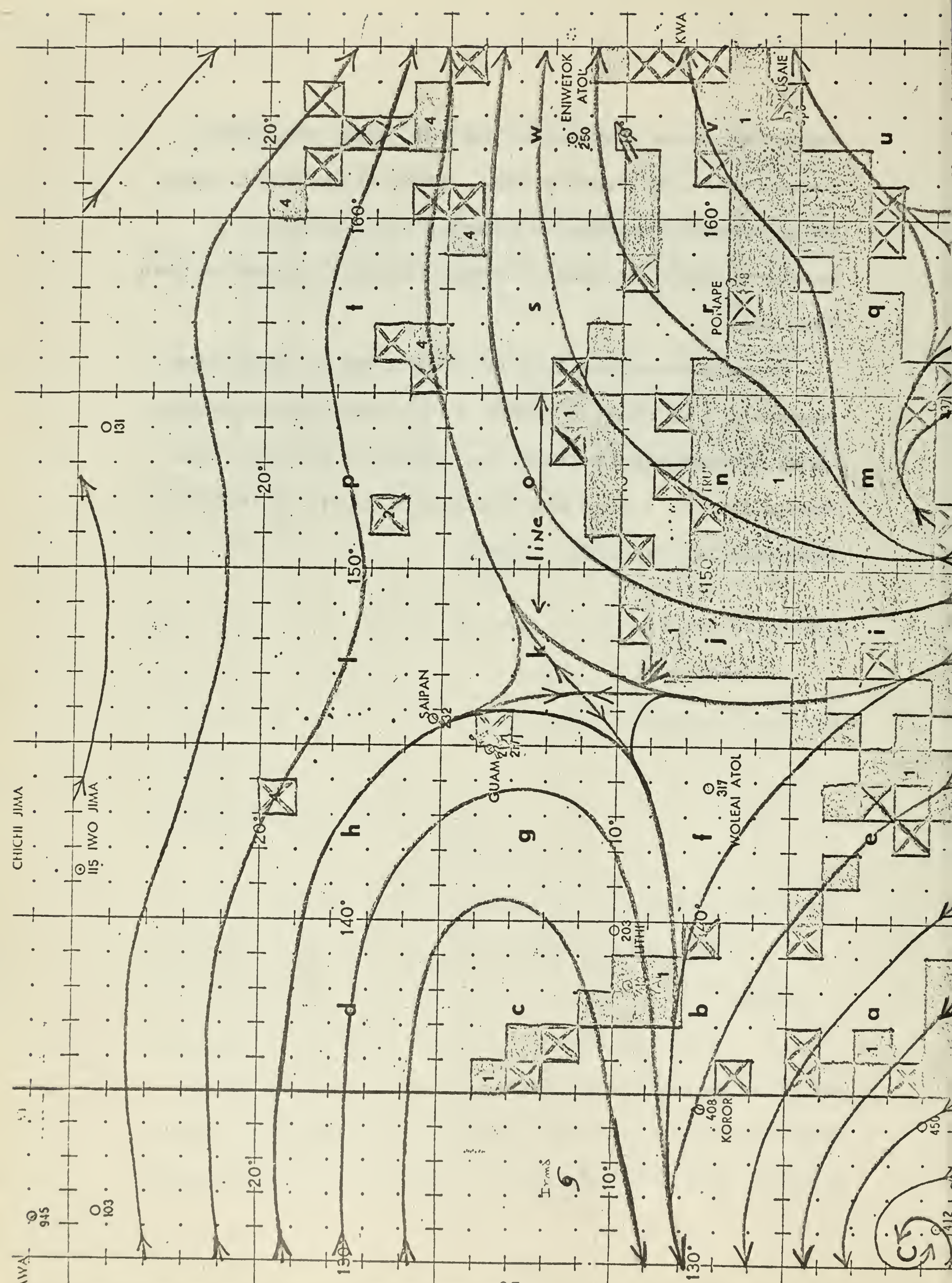
00Z 14 May 1966 (figures 13, 14, 15)

UPPER AIR

A look at figure 13 quickly confirms the "restlessness" that Riehl attributed to the tropical upper troposphere many years ago. Progressive troughs and ridges, cyclonic and anticyclonic vortices, convergent and divergent flow patterns are all found there.

A subtropical ridge line extends from 15N 130E eastward to 137E, thence northeastward out of the area. A Mid-Pacific upper tropospheric trough is evident in the extreme eastern portion of the area. A tropical anticyclonic vortex is located at 4.5N 157E. It has been moving northeastward to its present position. A tropical anticyclonic vortex and its divergent asymptote are intimately associated with a significant cloud mass while a convergent asymptote appears relatively cloud free.

The cyclonic vortex at 1.5N 130.5E at 13/00Z has moved northeastward to 7.5N 136.5E at 14/00Z. In an unusual case the cyclonic vortex, with laterally convergent flow, appears related to the cloud mass in blocks a, b and e (see discussion on the 24-hour isallobaric/isalloneph chart for 14/00Z - 13/00Z).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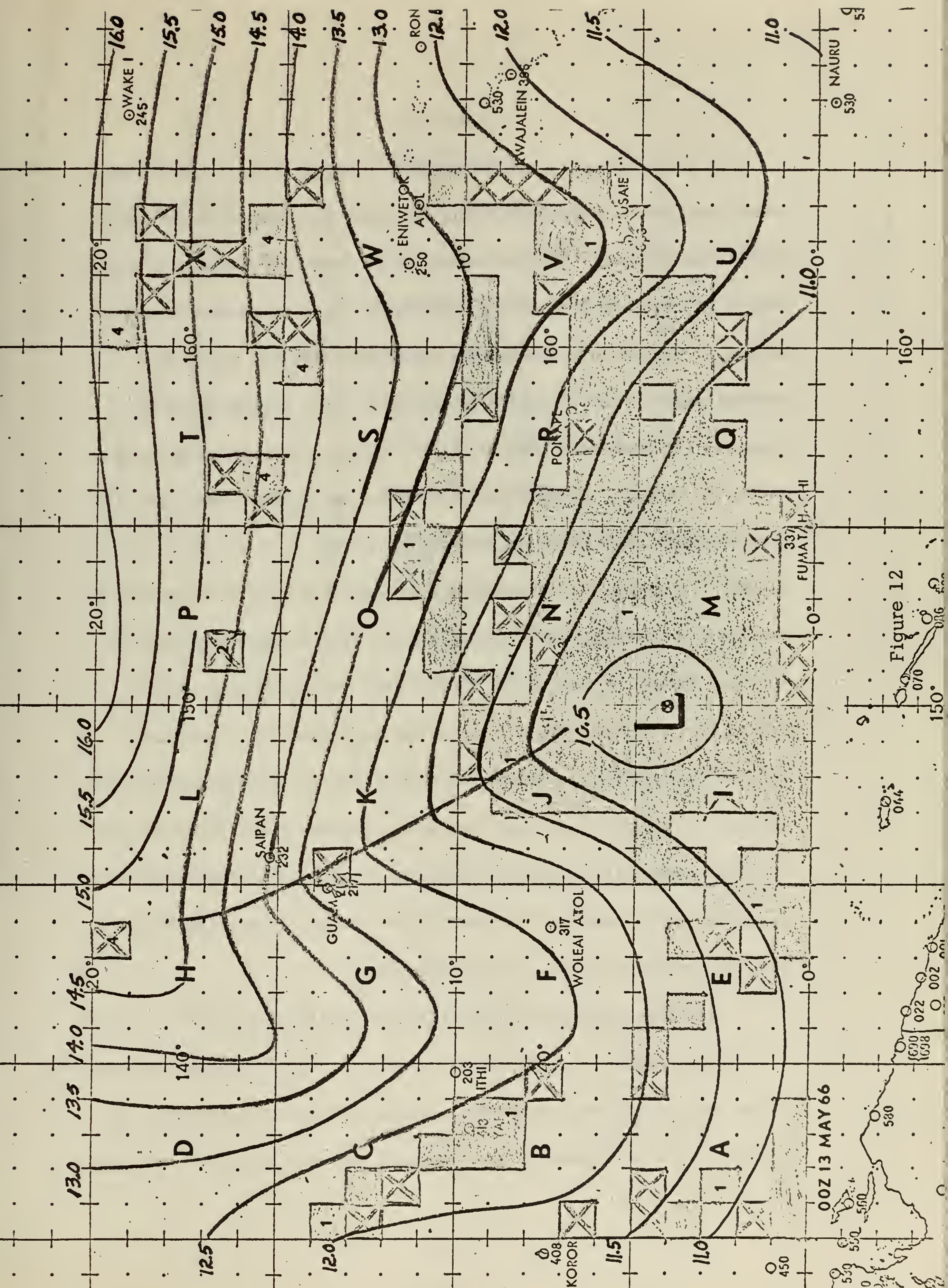
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0°
140°
150°
160°

Figure 12

SURFACE

The Intertropical Convergence Zone is north of its climatological mean position (see figure 2). Easterly flow with wavelike structure dominates the area. The low center at 4N 148E has moved due west at 5.0 kt for the past 24 hours. The large cloud mass associated with it at 13/00Z is in the process of contracting but shows more banded organization about the center now. This change in cloud organization correlates well with the lower pressure found in the low center at 14/00Z. Progressive ridge lines are located from 20N 145E and from 20N 165E south southwestward to the equator. A trough in the easterlies extends from 11N 153E northeastward out of the area. It is difficult to establish continuity with the easterly trough on the 13/00Z chart. The troughs at both 13/00Z and 14/00Z resemble Palmer's wavelike perturbations. Both are associated with an extensive cloud mass and are superimposed on the equatorial trough. It is very tempting to equate both the 13/00Z and 14/00Z meridionally oriented troughs to the classical easterly wave model of Riehl, however, the distribution of the cloud mass (Table 2, type 1) about the trough is in disagreement.

24-Hour ISALLOBARIC/ISALLONEPH CHART FOR 14/00Z - 13/00Z

Typhoon Irma, at 13/00Z was located at 11N 132.5E and segments of her main cloud band appeared in blocks b and c at that time. At 14/00Z she was downgraded to a tropical storm (a somewhat surprising

TABLE II

CLOUD TYPE	MEANING
1	A mass of convectively produced clouds associated with a low level perturbation except those associated with 3.
2	Clouds associcated with the cold lows, troughs or shear lines at upper tropospheric levels.
3	Frontal or frontally induced clouds.
4	Indeterminate , but thought to be clouds related to cold lows, troughs or shear lines at mid-tropospheric levels.

development in view of Irma's geographical location and cloud system as seen in the APT cloud pictures at 13/00Z) located at 9.5N 129.5E. Therefore, she had moved west southwestward in agreement with the flow at 250 mb. At 14/00Z portions of her main cloud band are located in blocks a, b and e. It is interesting to note that a 250-mb cyclonic vortex had moved over Irma's main band during the period 13/00Z to 14/00Z which resulted in an unfavorable outflow pattern and led to Irma's weakening.

Other cloud changes in blocks f, i, j, southern k, m, n, southern o, q, r, u, v and w were due to the moving surface perturbation at 4N 149E. The changes elsewhere were due to type 2, 3 and 4 effects.

In figure 15, 82 per cent of the cloud increase areas are found within the region enclosed by the less than or equal to -0.5-mb isallobar and 64 per cent of the cloud decrease areas are located outside the regions enclosed by the less than or equal to -0.5-mb isallobar.

Note the cloud mass over Truk at 13/00Z and 14/00Z (figures 12 and 14). Truk received 0.88 inches of rain during this period.

A Forecast of Clouds and Rainfall at Guam for the Period 14/00Z to 15/00Z

The major (type 1) cloud mass to the east of Guam has moved west northwest at approximately nine knots during the past 24 hours, while the low associated with it has moved at only five knots. Since the leading edge of the cloud mass was about 240 nm east southeast

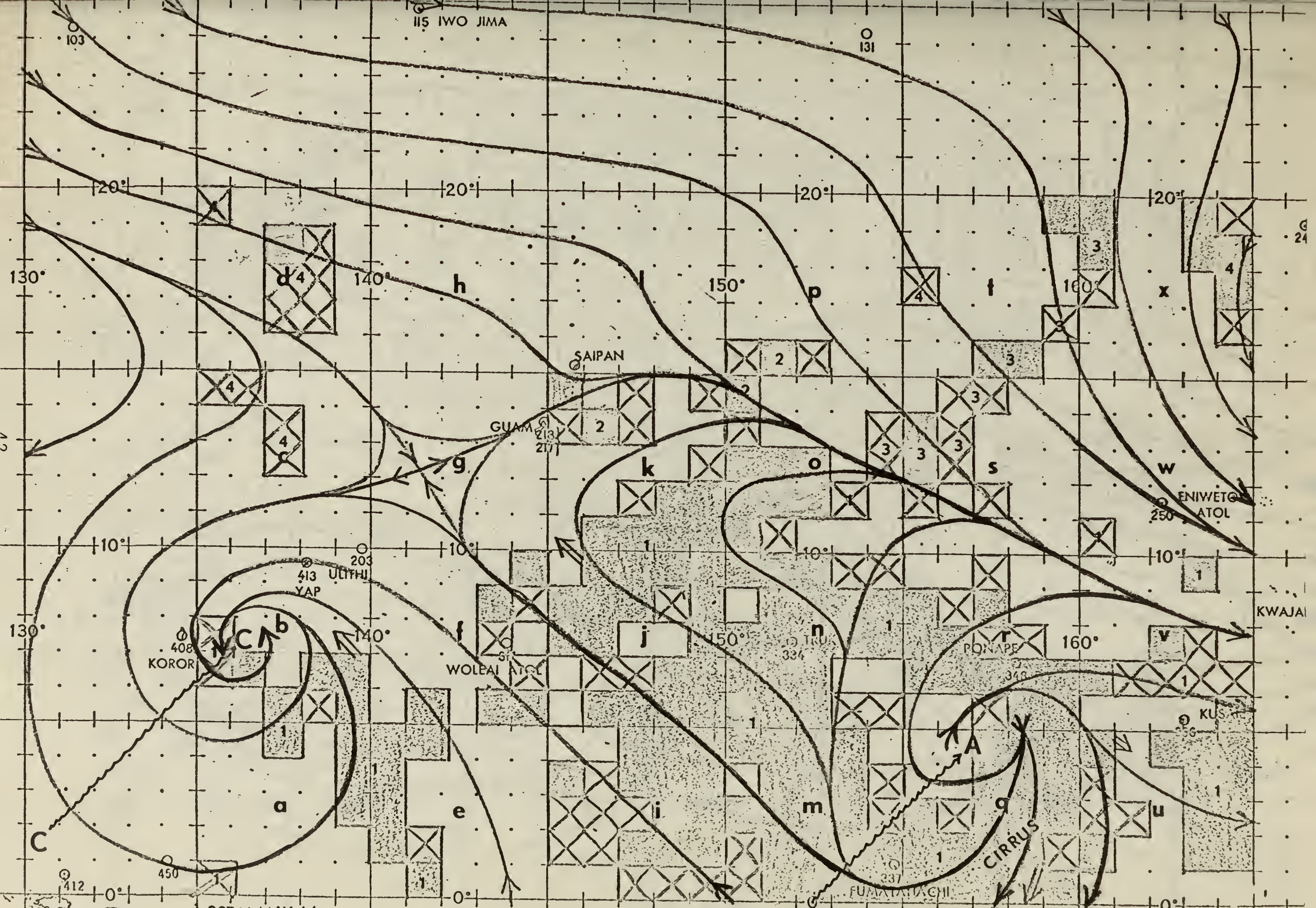

115 IWO JIMA
103
131
130°
140°
150°
160°
20°
10°
0°
SAIPAN
GUAM
213
217
ULITHI
203
413
YAP
408
KOROR
WOLEAI ATOL
TRUK
334
PONAPE
348
KUSAIE
ENIWETOK ATOL
250
KWAJAI
FUNAFUTI
337
CIRRUS
412
450
530
550
00Z 14 MAY 66

Figure 13

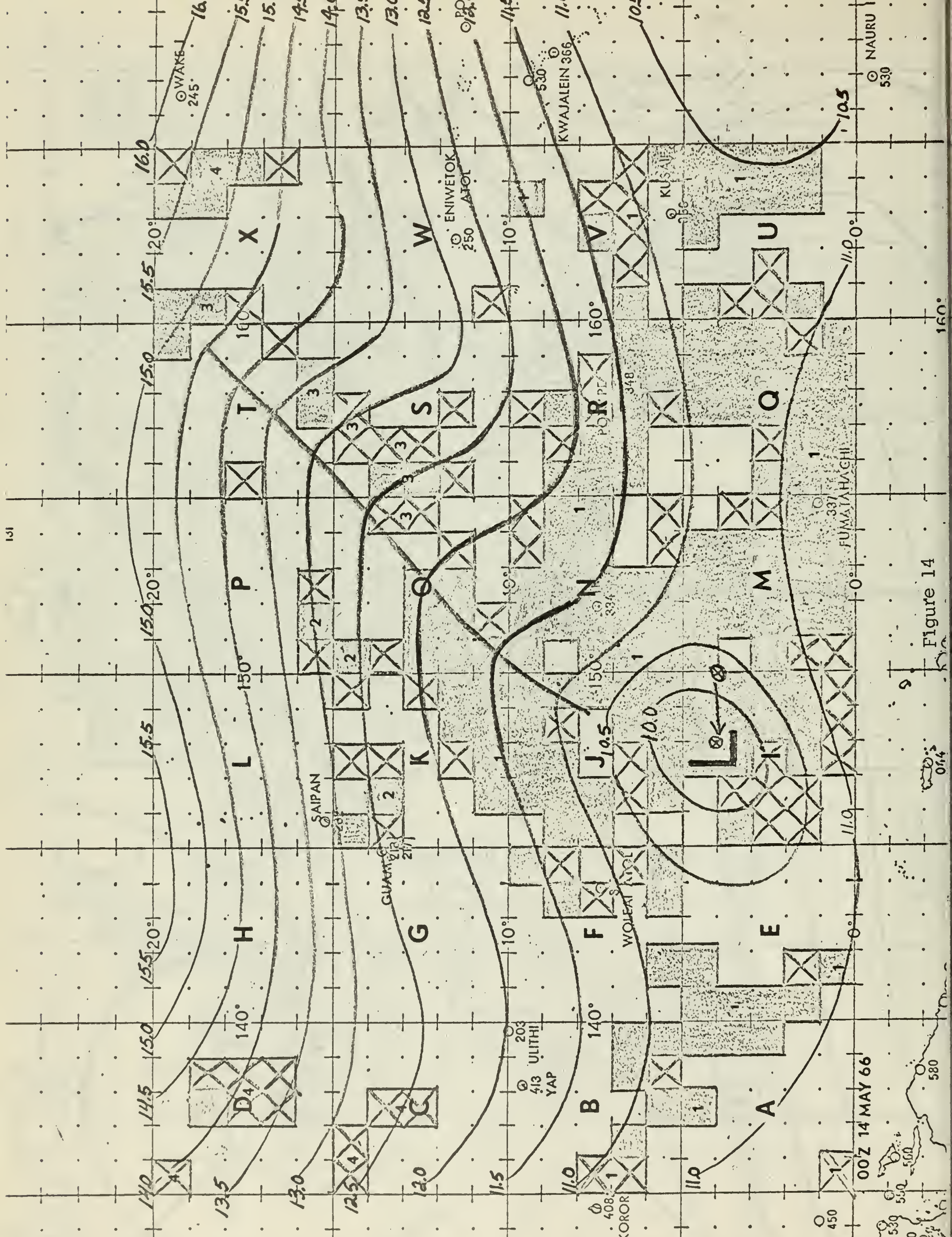

00Z 14 MAY 66
WAKE
ENIWETOK ATOL
KWAJALEIN
KUSAIE
NAURU
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI
PONAPE
FUMATAHACHI
L

Figure 14

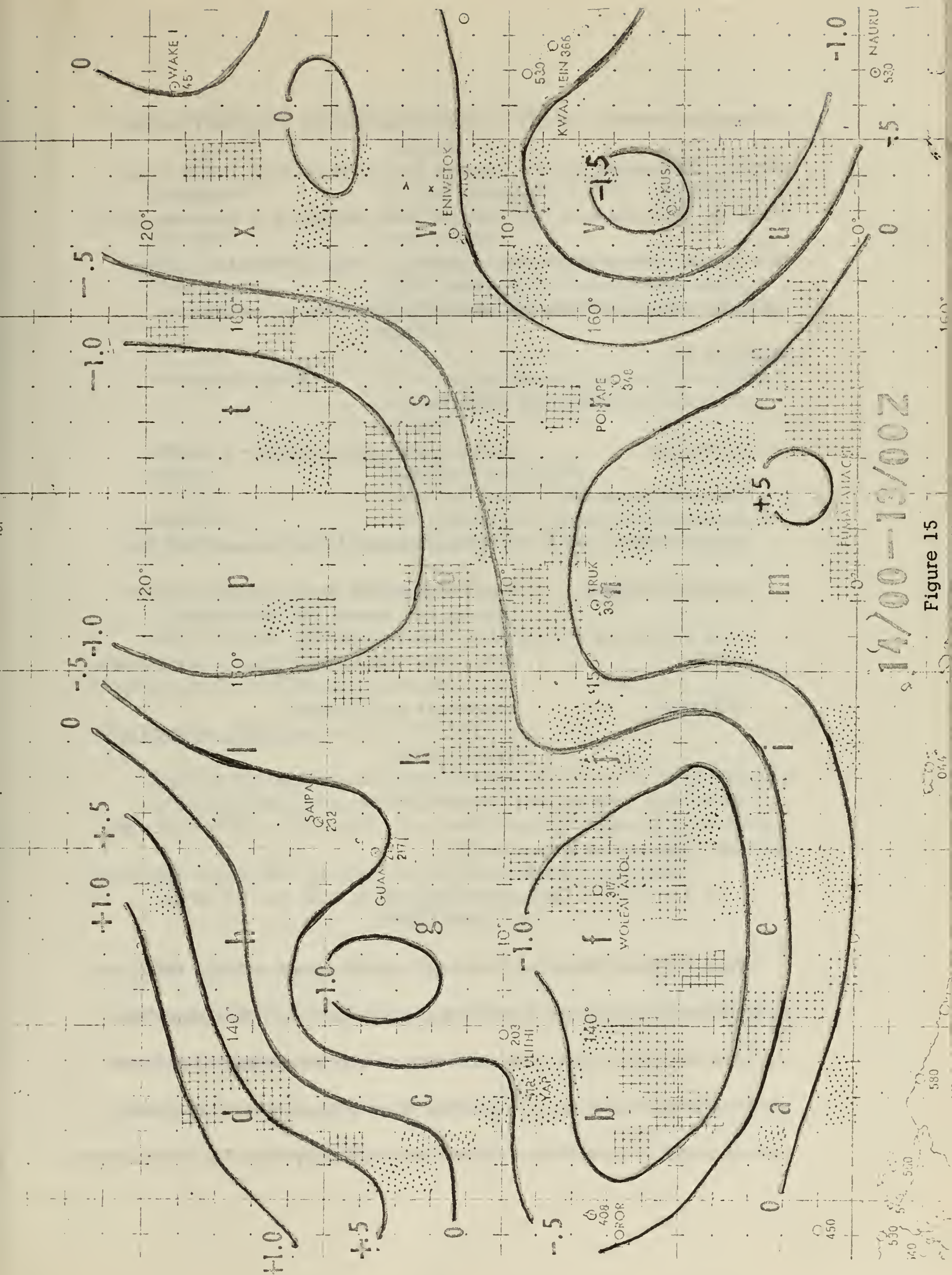


Figure 15

of Guam no shower activity should be expected during the forecast period. The reader should compare the above outlook to that which would be obtained from conventional observations and analyses used in a single station silent area approach. This information, given below, is condensed from the vertical cross section for Guam in Appendix II.

TABLE

Parameter	24-Hour Changes (14/00Z - 13/00Z)
Sea level pressure	fell 0.4 mb
temperature	decreases at all levels above 5000 feet
isobaric heights	decreases at all levels becoming more pronounced toward the tropopause
winds	easterlies veered with time at most levels
moisture	decreases at all levels

VERIFICATION

Good; one light shower occurred between 14/1213 to 1217Z totaling 0.02 inches (Appendix III).

A Forecast of Clouds and Rainfall at Truk for the Period 14/00Z to 15/00Z

Truk is 75 nm west northwest of a 120 nm break area in the cloud mass which has moved at nine knots toward the west northwest for the past 24 hours. At the eastern edge of the break area is a 20 nm wide cloud mass followed by another large break area. Therefore, shower activity should be expected to end shortly after 14/08Z followed by fair weather for at least the next 13 hours.

TABLE

Parameter	24-Hour changes (14/00Z - 13/00Z)
pressure	rose 0.3 mb
temperature	slight decreases at most levels except slight increases near the tropopause and surface
isobaric heights	slight decreases except increases from 300 mb to the tropopause and near the surface
winds	easterlies unchanged
moisture	slight decrease around 18,000 feet and slight increases elsewhere

VERIFICATION

Good; shower activity totaling 0.05 inches terminated at approximately 14/09Z (Appendix III).

00Z 15 May 1966 (figures 16, 17, 18)

For this and subsequent time periods only the more significant comments will be included. They will usually relate to noteworthy changes in the flow pattern from a previous analysis time.

UPPER AIR

The tropical anticyclonic vortex at 11.5N 133E originated as an eddy, at 16N 129.5E at 14/00Z (figures 9 and 13), that broke away from the subtropical high centered far to the northwest of the generation area. The cyclonic vortex at 11.5N 140E is nearly free of clouds and is east of the cloud band in blocks a, b, and c that are associated with Irma. Irma has now regained Typhoon intensity and is located at 10.5N 127.5E.

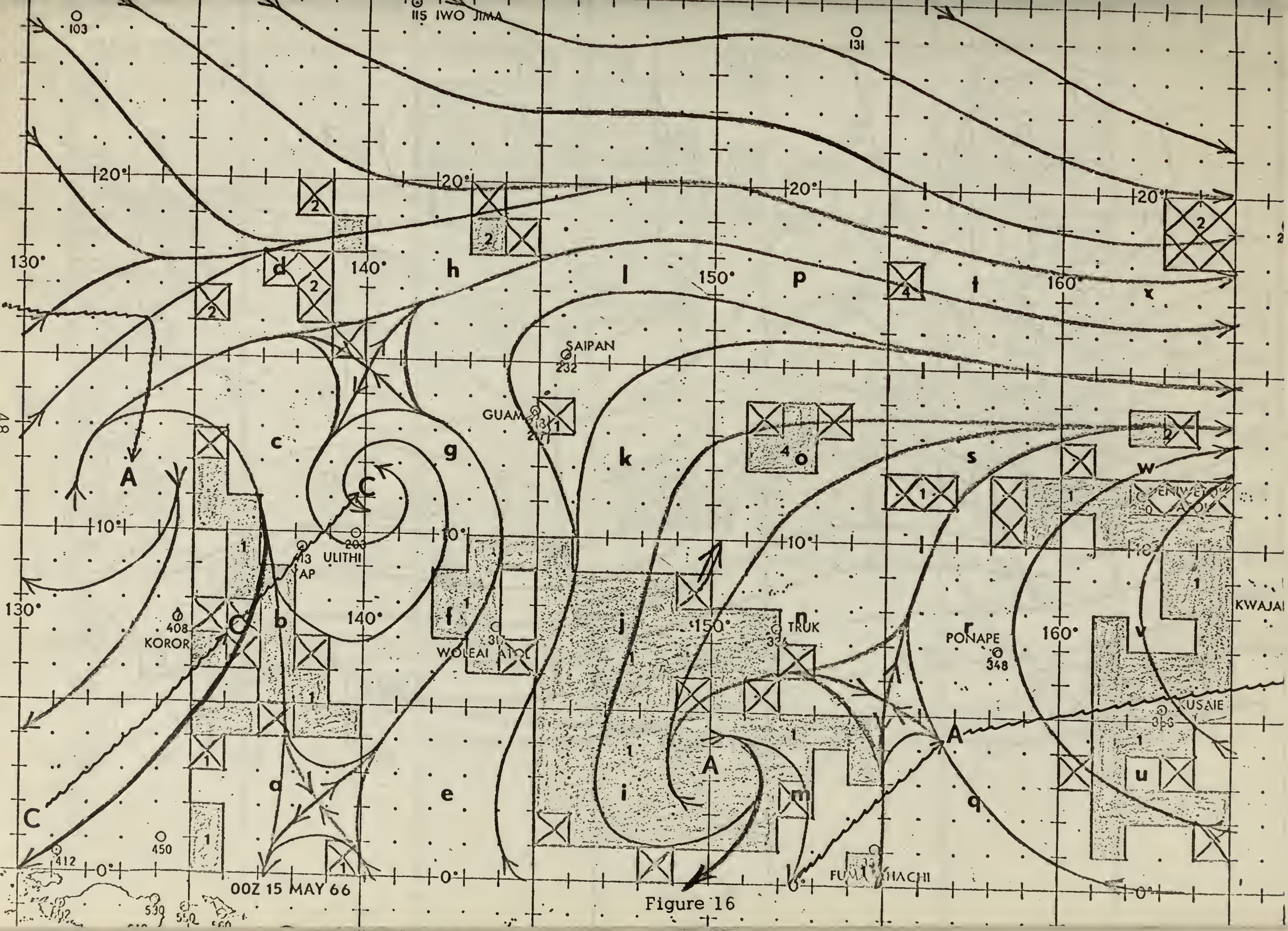
The tropical anticyclonic vortex at 3.5N 150E developed in the past 12 hours in a laterally divergent flow area to the southeast of an extended trough that passed through Guam shortly after 14/00Z (see Guam's time section around 14/00Z (Appendix II). Cloud types 2, 3 and 4 at 14/00Z helped confirm the existence and location of this weak trough. Either due to dissipation or superposition effects this trough is not visible at 15/00Z. Note the relatively high temperature (-40C) and isobaric height (11,030 meters) at Truk northeast of the forming tropical anticyclonic vortex at 15/00Z (Appendix II).

SURFACE

Note the cloud mass in blocks s and w (figure 17) which will become significant by 16/00Z. The low located at 6N 163.5E associated with this cloud mass has just moved into the eastern portion of the area.

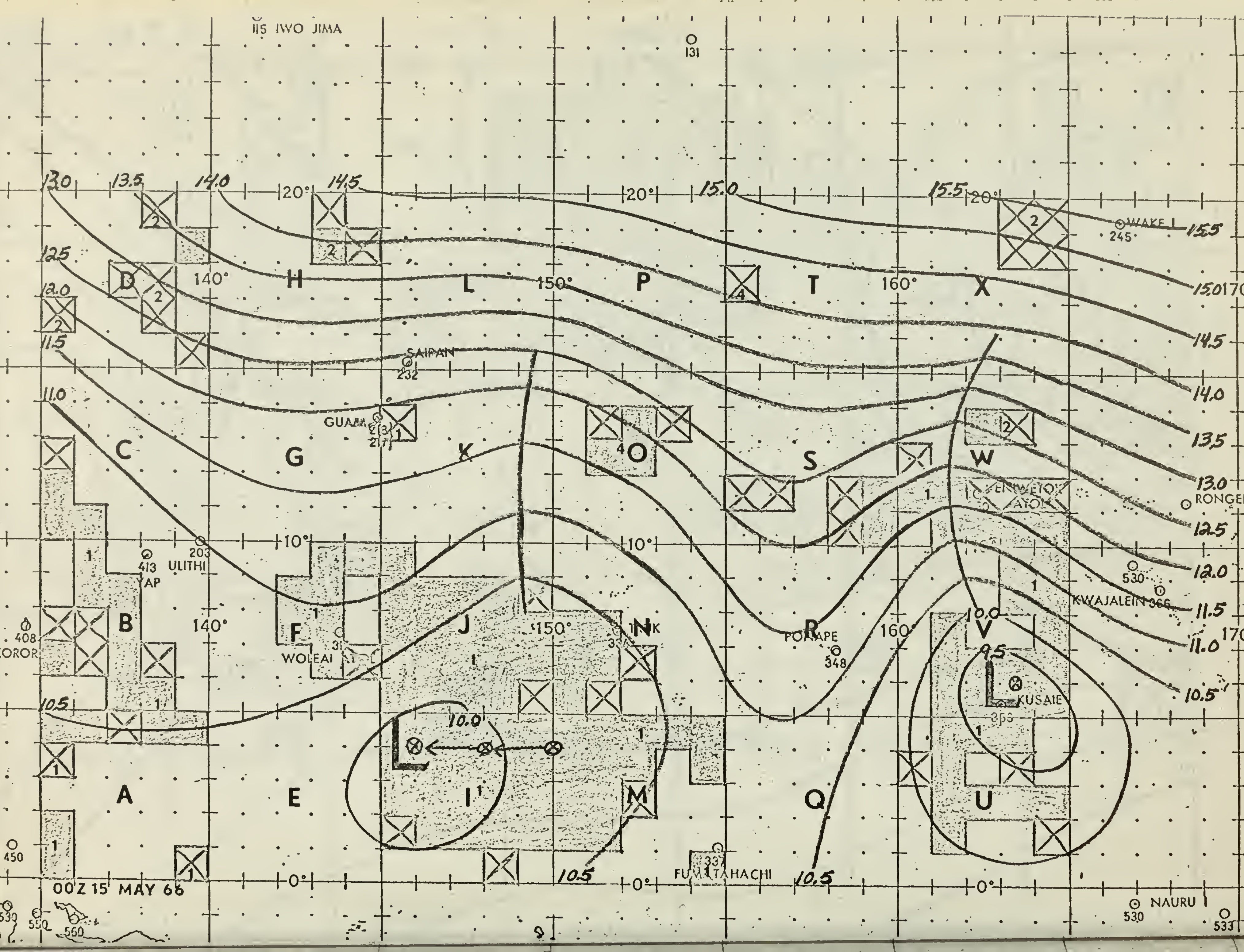
24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 15/00Z - 14/00Z

The central part of the chart is marked by a large area of decreasing cloud cover. This possibly reflects the rapid movement of the tropical anticyclonic vortex at 4.5N 157E at 14/00Z to the east northeast during the period 14/00Z to 15/00Z. Also, the low on the surface at 6N 163.5E at 15/00Z appears to be moving rapidly westward. The juxtaposition of the upper and low level systems



IWO JIMA
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
KWAJAI
FUMA HACHI
00Z 15 MAY 66

Figure 16


IWO JIMA
WAKE I
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI
PONAPE
KWAJALEIN
ENIWETOK ATOLL
RONGERIK
KUSAIE
NAURU
00Z 15 MAY 66

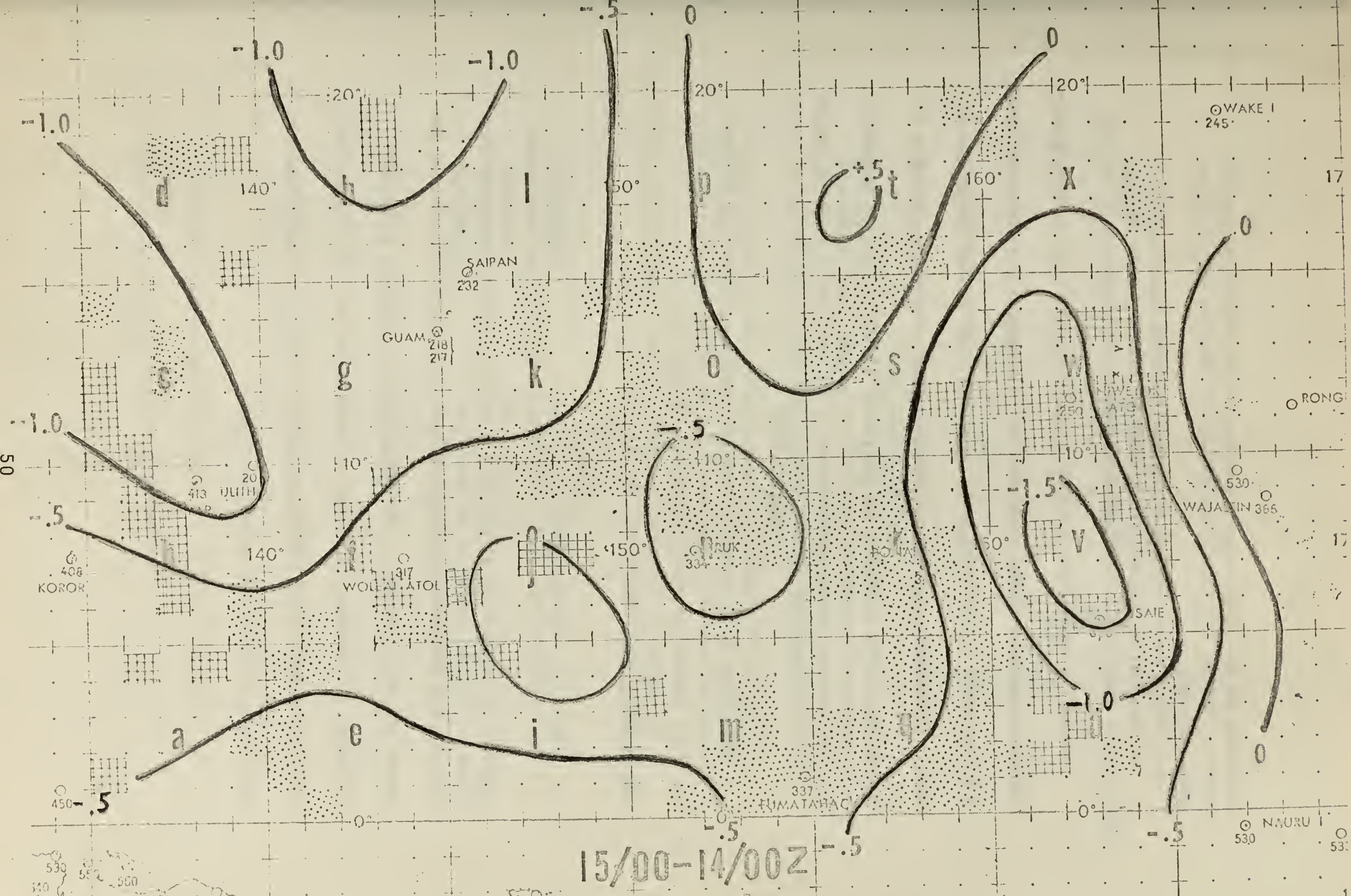

WAKE I
SAIPAN
GUAM
WOLEAI ATOL
KOROR
TRUK
PONAPE
KUSAIE
KAPINGAMARANGI
NAURU I
RONGELAP
15/00-14/00Z

Figure 18

accounts for the large cloud increases in the eastern part of the area studied.

A Forecast of Clouds and Rainfall at Woleai for the Period 15/00Z to 16/00Z

Woleai is covered by a cloud mass which has been moving westward at about five knots which is also the speed of the low at 4N 146E. A 60 nm break in the cloud mass is evident just to the east of the station followed by an extensive cloud mass. Therefore, little or no precipitation was predicted for the period 15/00Z to 15/12Z followed by more general shower activityfrom15/12Z until the end of the period.

VERIFICATION

Excellent; 0.02 inches of rain fell between 15/00Z and 15/06Z and 0.54 inches between 15/12Z and 16/00Z.

<u>00Z 16 May 1966</u> (figures 19, 20, 21)

SURFACE

The low at 6N 163.5E at 15/00Z has moved rapidly west southwestward to 4.5N 154E at 16/00Z. The cloud mass associated with this low has decreased markedly in size and organization during the period 15/00Z to 16/00Z. The perturbation at 4N 146E at 15/00Z increased its forward speed and is now located at 3.5N 141E. The cloud mass associated with this low has also decreased in size and organization during the period.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 16/00Z - 15/00Z

The large cloud decrease and increase areas again reflect, in general, the same upper and low level system relationship as discussed in 15/00Z.

The areas of increase in blocks r and western v appear due to development in situ.

A Forecast of Clouds and Rainfall at Guam for the Period
16/00Z to 16/00Z

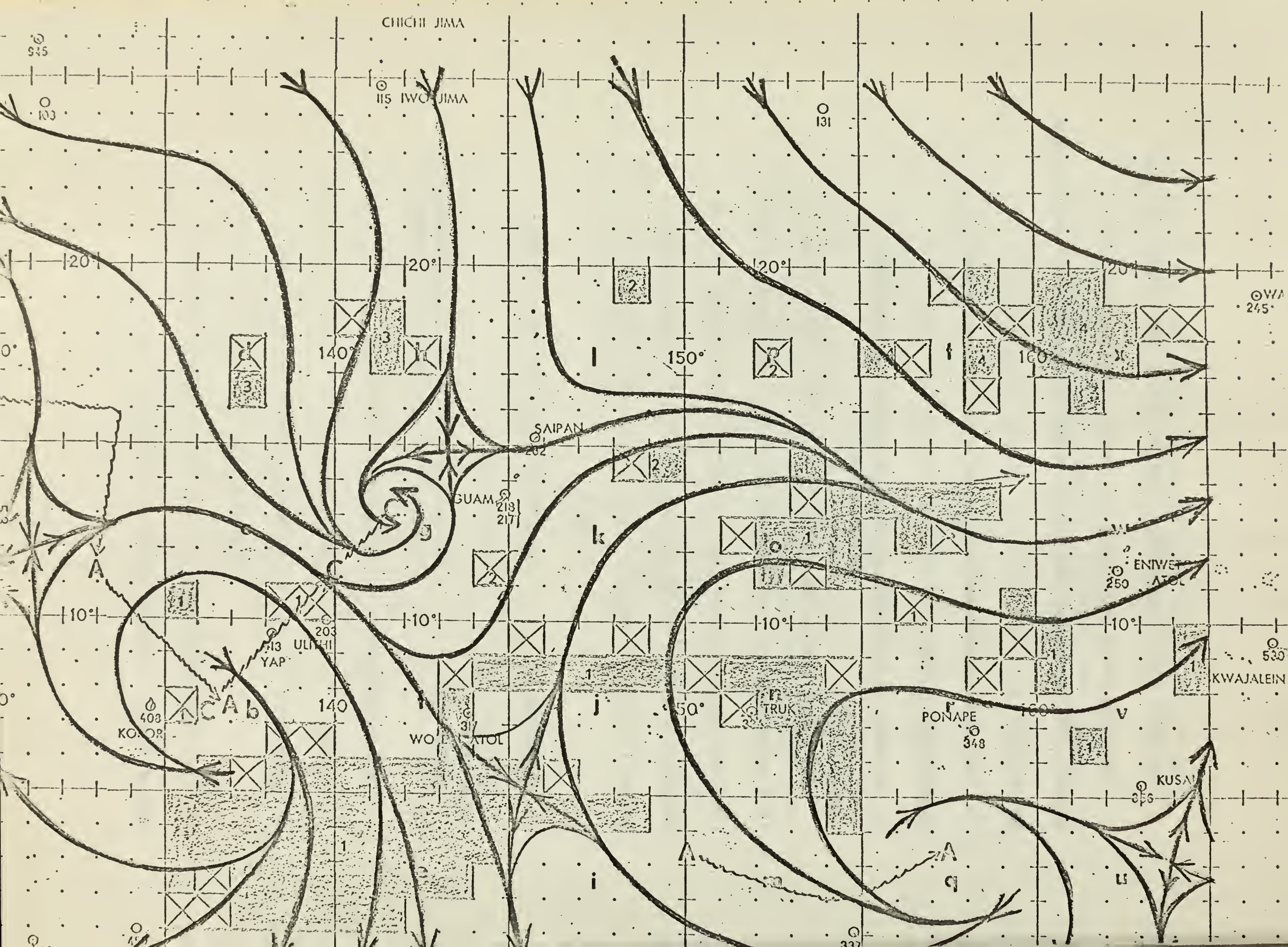
The cloud mass noted at 15/00Z has moved west northwest at 17.5 kt into blocks o and s by 16/00Z. Since the leading edge of the cloud mass is 360 nm east southeast of Guam at 16/00Z it is predicted to move over the station attended by shower activity around 16/21Z and remain at least until the end of the period.

TABLE

Parameter	24-Hour Changes (16/00Z - 15/00Z)
pressure	fell 0.3 mb
temperature	decreases at all levels excpet increases around 400 mb and near the tropopause
isobaric heights	decreases at all levels
winds	little change
moisture	slight decrease above 6000 feet

VERIFICATION

Excellent; shower activity began at 16/2030Z and lasted for several hours. Rainfall totaled 0.34 inches.


CHICHI JIMA
115 IWO JIMA
SAIPAN
262
GUAM
213
217
ULITHI
203
YAP
113
KOROR
408
WOLEAI ATOL
TRUK
PONAPE
348
ENIWETOK ATOL
250
KWAJALEIN
KUSAIE
20°
10°
140°
150°
160°

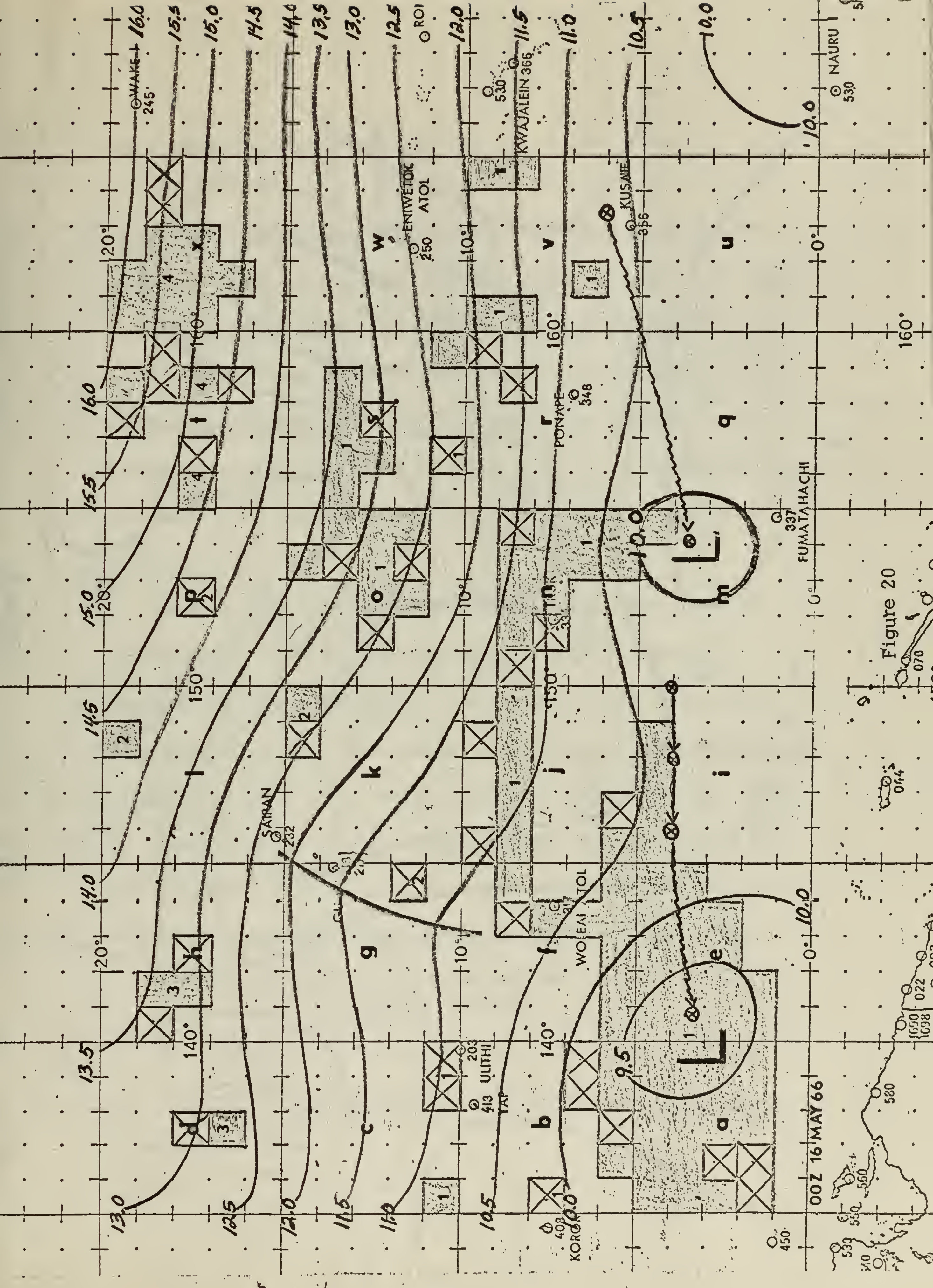

00Z 16 MAY 66
WAKE
ENIWETOK ATOL
KWAJALEIN
NAURU
KUSAIE
PONAPE
FUMATAHACHI
SAIPAN
ULITHI
KOROR

Figure 20

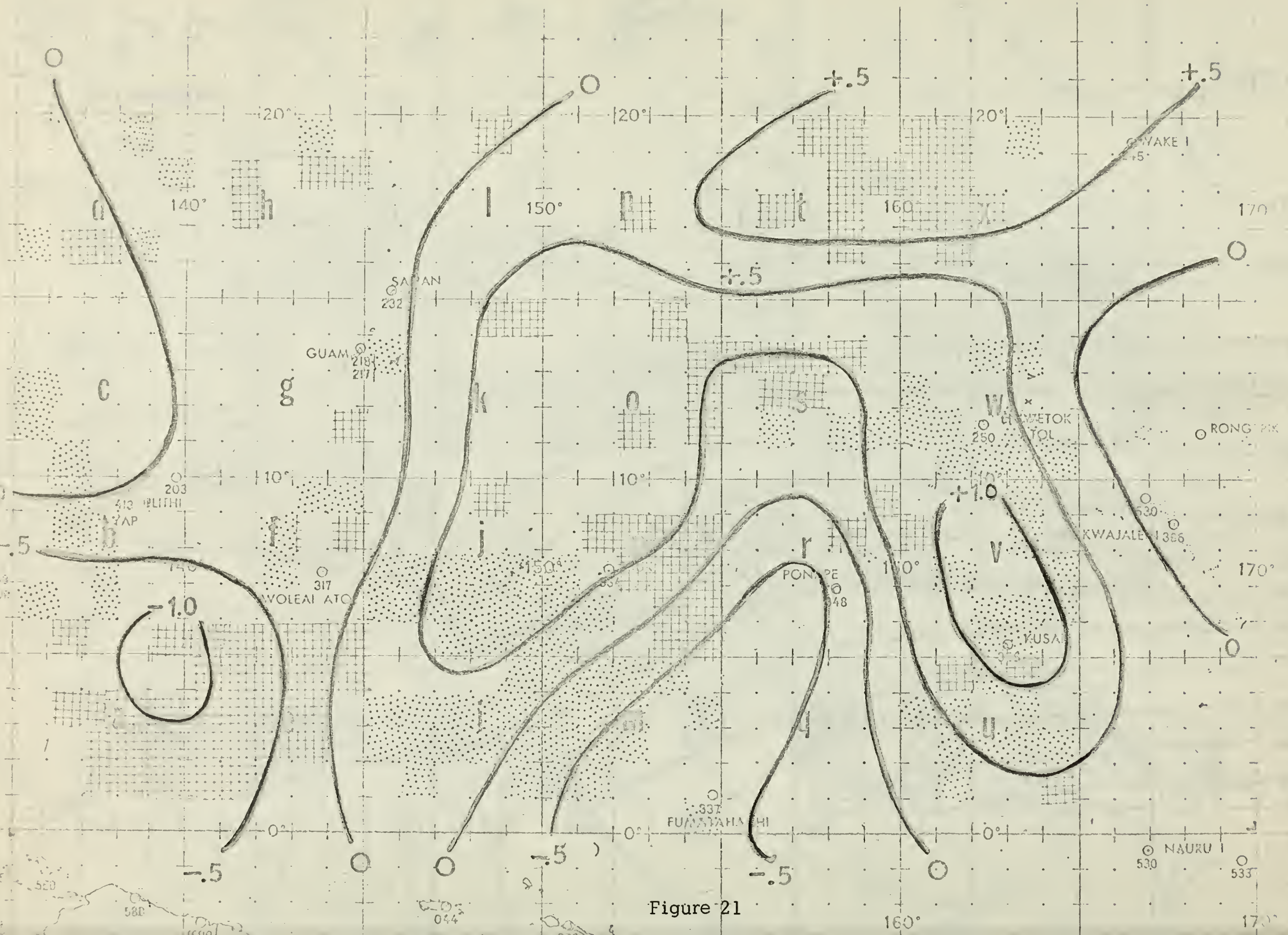


Figure 21

00Z 17 MAY 1966 (figures 22, 23, 24)

SURFACE

The major cloud mass which covers a large part of the area under study compares favorably with Palmer's convergent model (6, chpt 9).

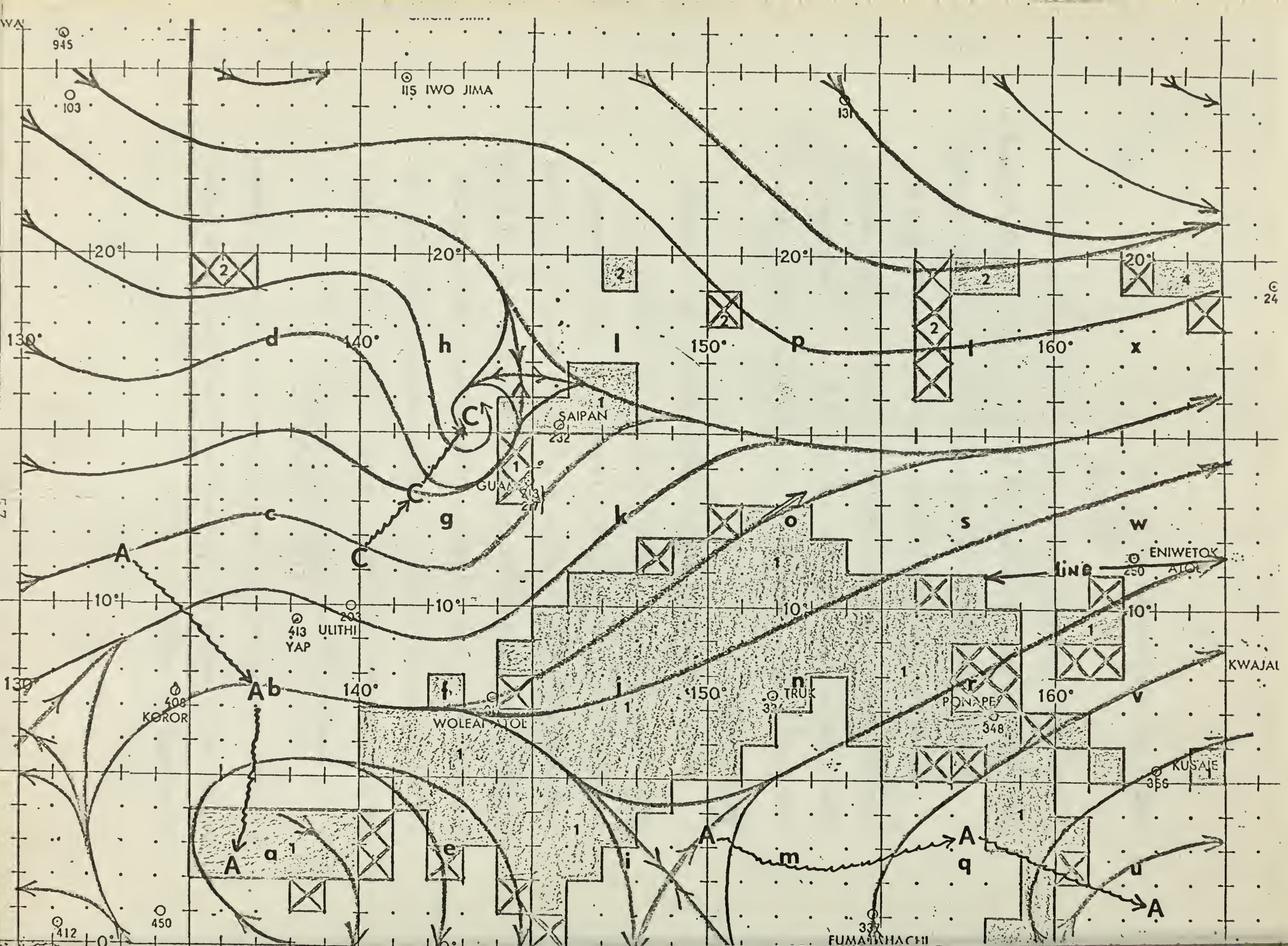
24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 17/00Z - 16/00Z

The area of large cloud increase appears to be related more to increased lateral divergence aloft than to 24-hour sea level pressure falls in the interval 16-17 May in blocks e, f, i, j, k, western o, and western n, while the latter effect seems dominant in blocks eastern n and o, r, s, and v.

The isalloneph chart was used in combination with an area of cloud breaks in block e, and a truncation of the cloud mass in eastern n (as seen in figure 23) to associate the cloud masses with surface perturbations. In particular, the cloud mass in blocks a and western e is associated with the surface perturbation at 1.5N 135.5E. The remainder of the cloud mass is associated with the low at 1.5N 146.5E except that in blocks q, r, eastern n, u and v the clouds are affiliated with the trough located near the center of blocks q and r.

A Forecast of Clouds and Rainfall at Guam for the Period 17/00Z to 18/00Z

The cloud mass that is over the station is moving west northwest at 17.5 kt and should not cause any more precipitation at the station in the next 24 hours.



115 IWO JIMA
SAIPAN
232
GUAM
ULITHI
203
413
YAP
408
KOROR
WOLEAI ATOL
TRUK
PONAPE
348
ENIWETOK ATOL
250
KWAJAL
KUSAIE
356
FUMAISHACHI
line
130°
140°
150°
160°
20°
10°
0°
945
103
131
24
412
450

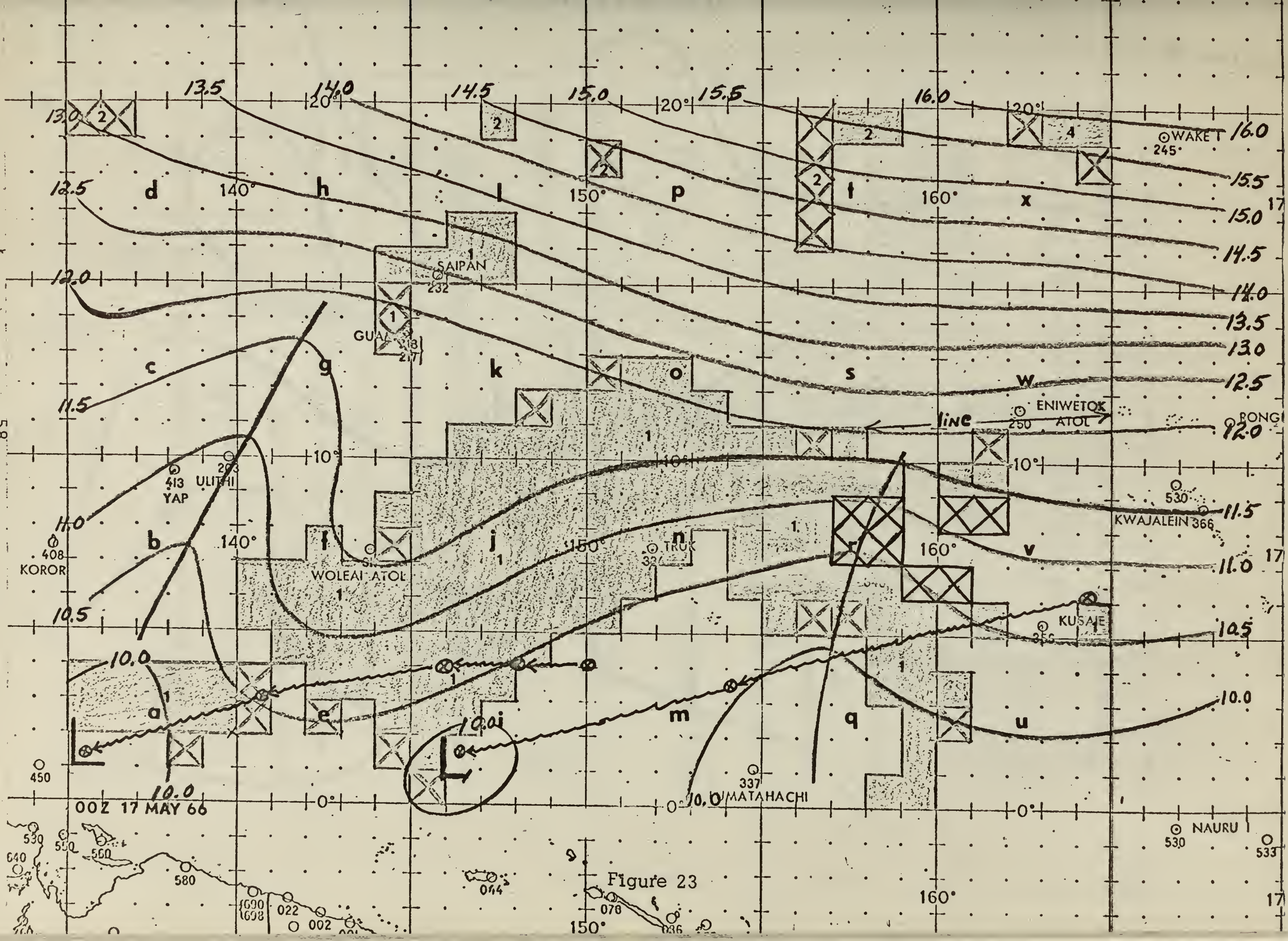
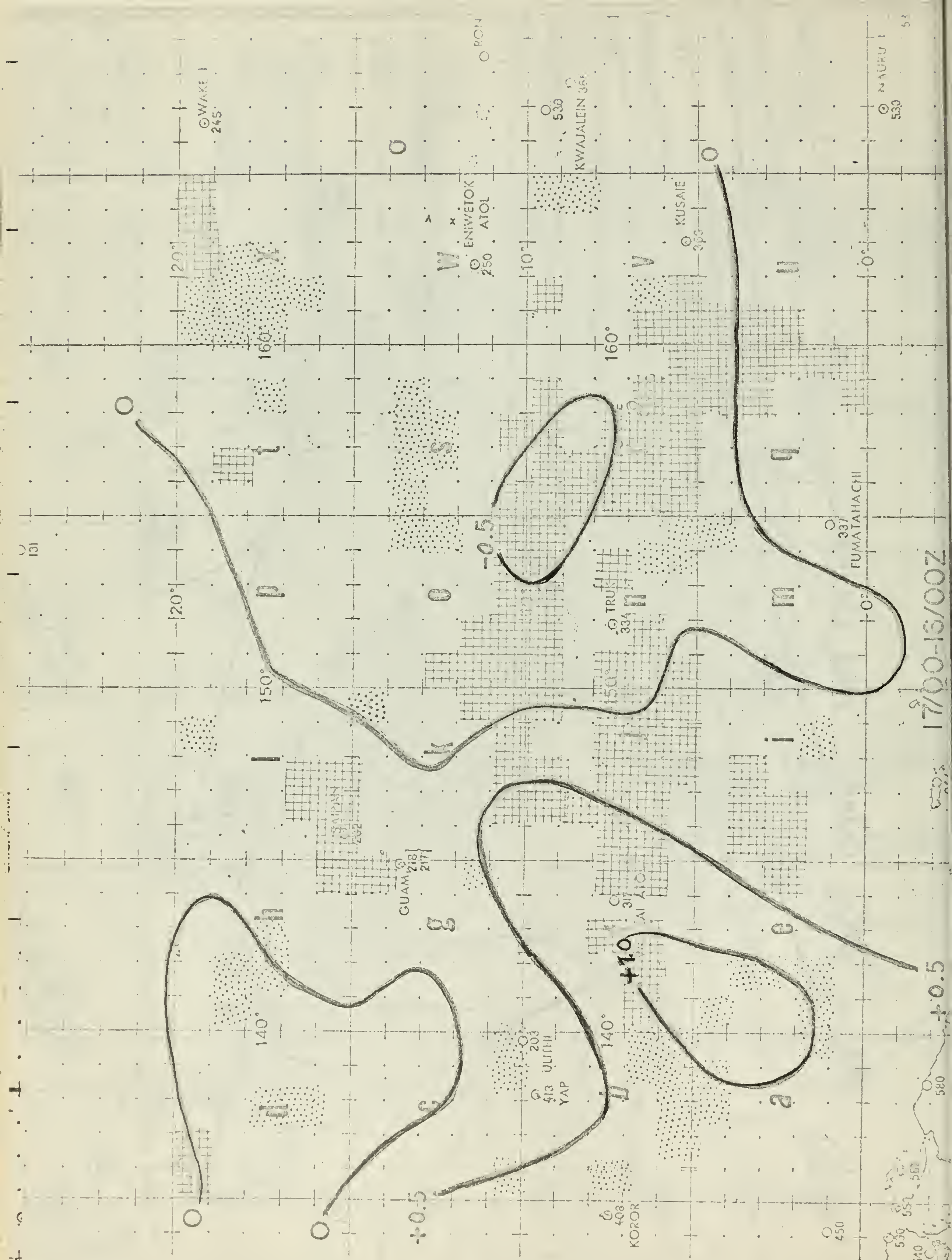

13.0
13.5
14.0
14.5
15.0
15.5
16.0
12.5
12.0
11.5
11.0
10.5
10.0
10.0
10.0
10.0
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
WAKE I
245
SAIPAN
232
GUAM
ENIWETOK ATOL
250
line
RONG
YAP
413
ULITHI
203
KOROR
408
WOLEAI ATOL
TRUK
KWAJALEIN 366
530
KUSAIE
MATAHACHI
337
NAURU
530
533
450
00Z 17 MAY 66
140°
150°
160°
20°
10°
0°
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t
u
v
w
x

Figure 23



17/00-16/00Z
WAKE I
245
ENIWETOK
ATOL
250
KWAJALEIN
KUSAIE
NAURU I
530
SAIPAN
GUAM
TRUK
334
ULITHI
203
YAP
413
KOROR
406
FUMATAHACHI
337
150°
160°
140°
20°
10°
0°
-0.5
+0.5
+1.0
0

The leading edge of an advancing cloud mass is 310 nm southeast of the station. It is moving north northwest at 5 kt and therefore should not reach the station during the forecast period.

TABLE

Parameter	24-Hour Changes (17/00Z - 16/00Z)
pressure	increased 0.3 mb
temperature	decreases near 300 mb and the tropopause; increases at other levels
isobaric heights	slight increases or no change at all levels
winds	easterlies veered above 5000 feet and backed below
moisture	increased slightly, except fell near 850 mb

VERIFICATION

Excellent; no precipitation occurred at the station.

00Z 18 MAY 1966 (figures 25, 26, 27)

UPPER AIR

The tropical anticyclonic vortex southwest of Ponape (-39C) has just developed. Some of the conditions that were associated with the generation of this vortex were indicated at 17/00Z by the lateral divergence in the streamline flow and the warm temperature at Truk (Appendix II). Also, warm air was being advected northward east of the vortex at 15.5N 144.5E which helped to build the ridge oriented northwest to southeast from 25N 152E to the tropical anticyclonic vortex at 18/00Z.

SURFACE

The low center at 5N 139.5E has moved northwest for the past 24 hours. The central pressure of this low has decreased while the cloud mass associated with it has increased in organization and decreased in size.

The cloud line located just south of Eniwetok at 17/00Z is over the station at 18/00Z. It appears to be the line of demarcation between the disturbed weather area to the south and the stable trade wind area to the north.

The perturbation just east of 150E has very few clouds associated with it and is doubtless of little significance.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 18/00Z - 17/00Z

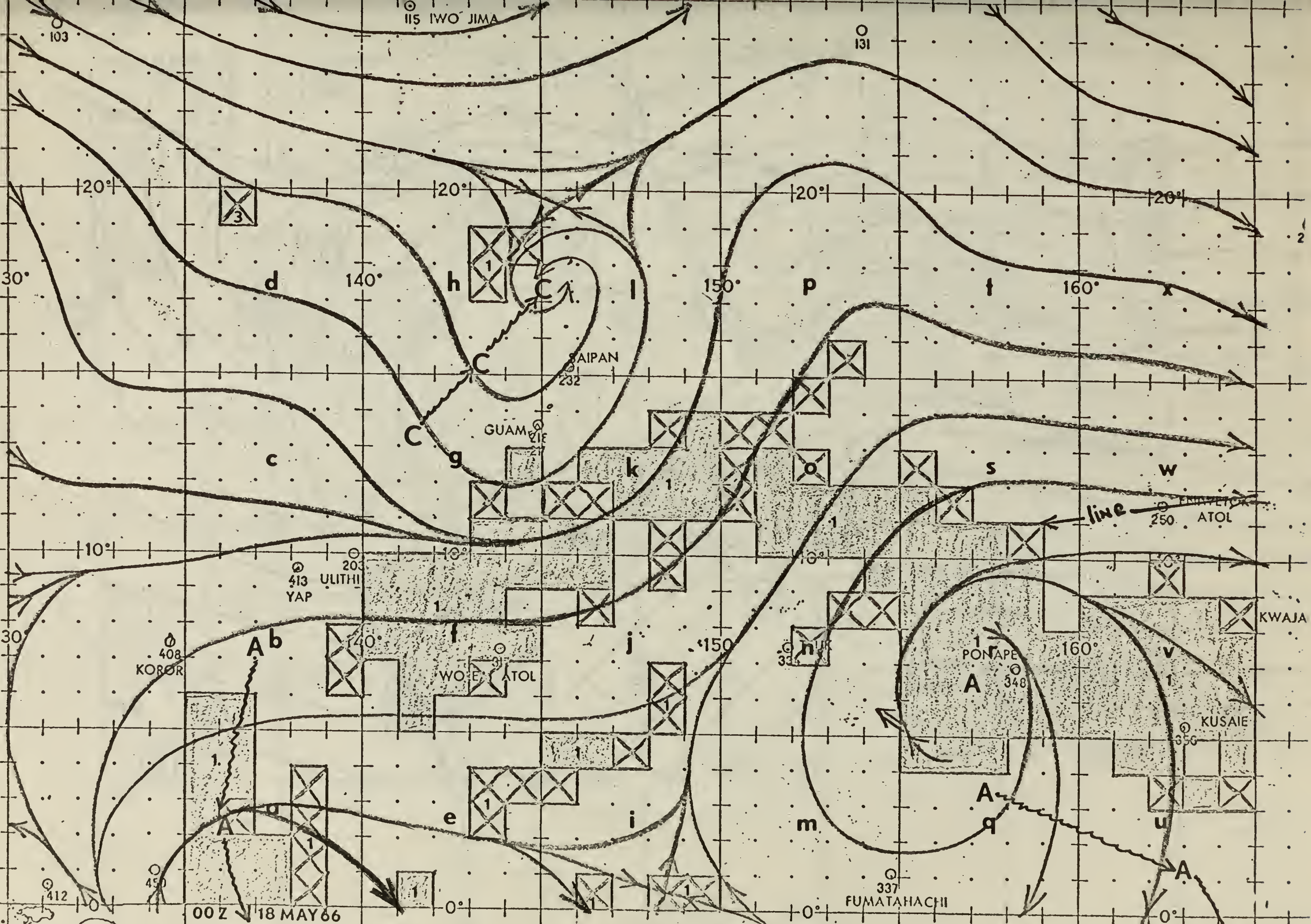
Once again the cloud change increases in blocks u, v, r, s and q definitely appear more intrinisically associated with the increased lateral divergence in those areas than with the 24-hour isallobaric changes.

A Forecast of Clouds and Rainfall at Yap for the Period 18/00Z to 19/00Z

The leading edge of an extensive cloud mass 110 nm east of Yap is moving westward at 11 kt. Shower activity is predicted for the period 18/10Z until the end of the period.

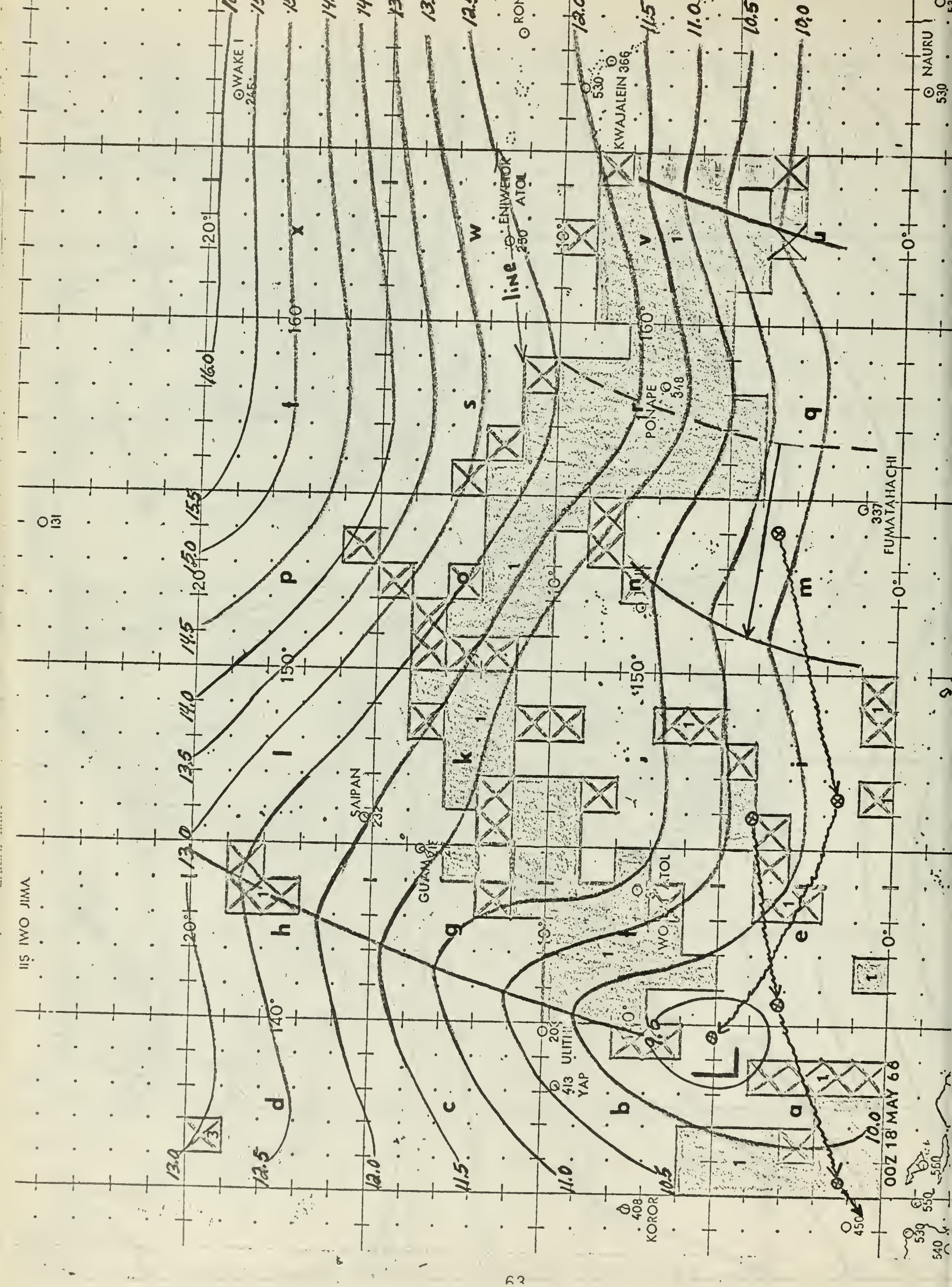
VERIFICATION

Fair to good, shower activity commenced as early as 18/03Z but 1.10 inches of the total 1.16 inches fell after 18/08Z.



IWO JIMA
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOL
PONAPE
KUSAIE
KWAJA
ATOL
FUMATAHACHI
line
00 Z 18 MAY 66

Figure 25



115 IWO JIMA
WAKE I
245
KWAJALEIN 366
ENIWETOK ATOLL
250
PONAPE
318
FUMATAHACHI
337
SAIPAN
232
GUAM
ULITHI
203
YAP
413
KOROR
408
NAURU
530
line
00Z 18 MAY 68

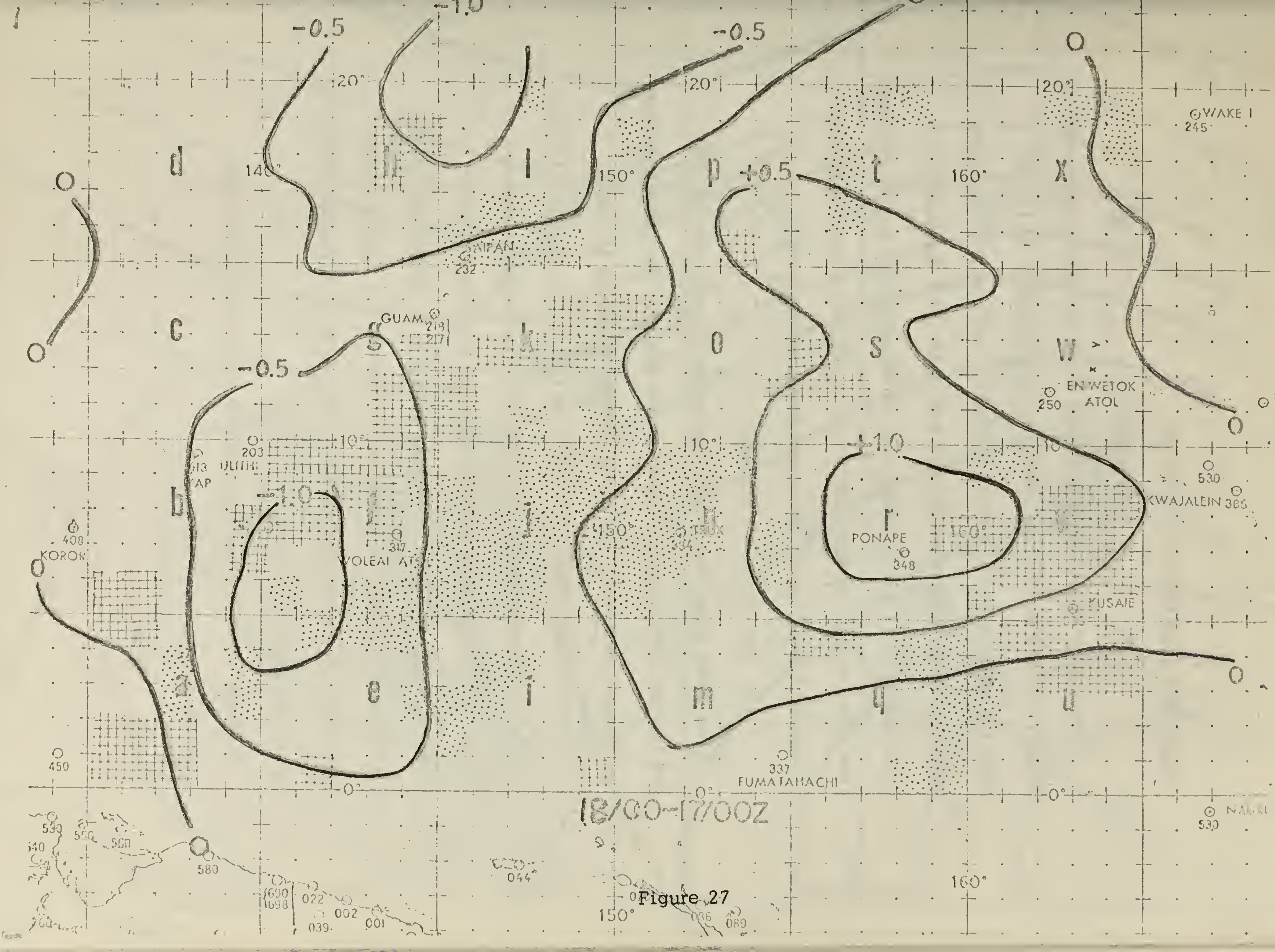

18/00-17/00Z
WAKE I
245
EN WETOK ATOL
250
KWAJALEIN 385
530
KUSAIE
NAURI
530
PONAPE
348
TRUK
334
FUMATAHACHI
337
GUAM
218
217
SAIPAN
232
ULITHI
203
YAP
313
VOLEAI AT
317
KOROR
408
450
580
044
+0.5
+1.0
-0.5
-1.0
0
20°
10°
0°
140°
150°
160°
a
b
c
d
e
i
k
l
m
o
p
q
r
s
t
u
w
x

Figure 27

00Z 19 MAY 1966 (figures 28, 29, 30)

UPPER AIR

The tropical anticyclonic vortex at 7.5N 142.5E was generated close to 19/00Z in a manner similar to that discussed at 18/00Z. Note the advancing trough west of blocks c and d at 18/00Z (figure 25). Also Yap has a temperature of -39C and Guam -37C (Appendix III). Note that blocks j and n should come under increasing lateral divergent flow if the tropical anticyclonic vortex moves in a southeast direction normal for this section of the experiment area (figure 9).

SURFACE

The cloud mass associated with the low located at 7.5N 137E has become more organized about the low center. The central pressure has dropped another 0.5 mb in the interval 18/00Z to 19/00Z.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 19/00Z - 18/00Z

There are extensive cloud decreases, especially in blocks s, r and v. Since they occur where 24-hour sea level pressures fell around 2.0 mb, the cloud decreases appear to be due to the 250-mb tropical anticyclonic vortex at 6.5N 157E at 18/00Z moving southeastward to 2N 163E by 19/00Z and resulting in non-divergent flow moving into the blocks mentioned above.

Areas of cloud increase in southern block e are due to cross-equator movement of a cloud mass.

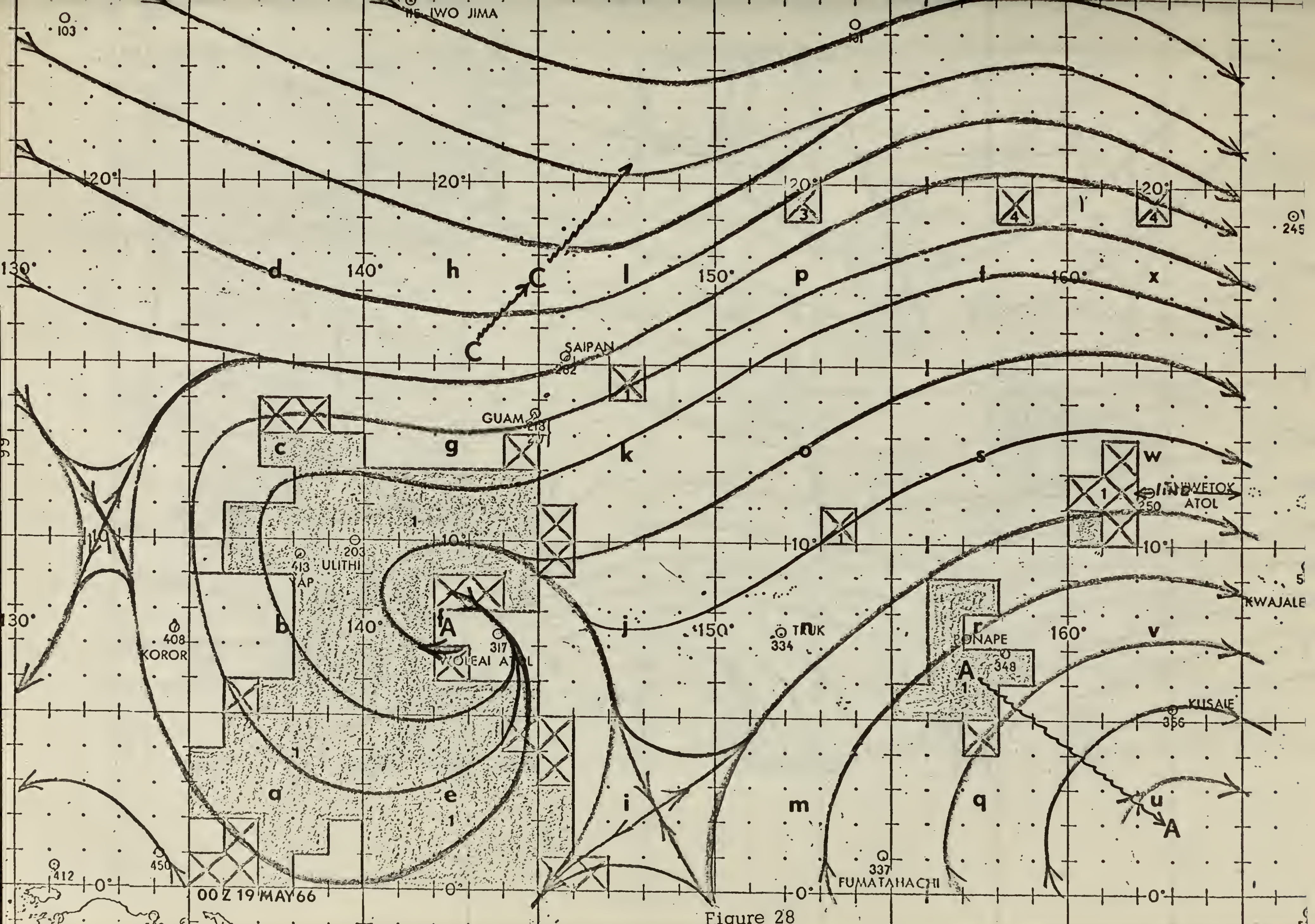
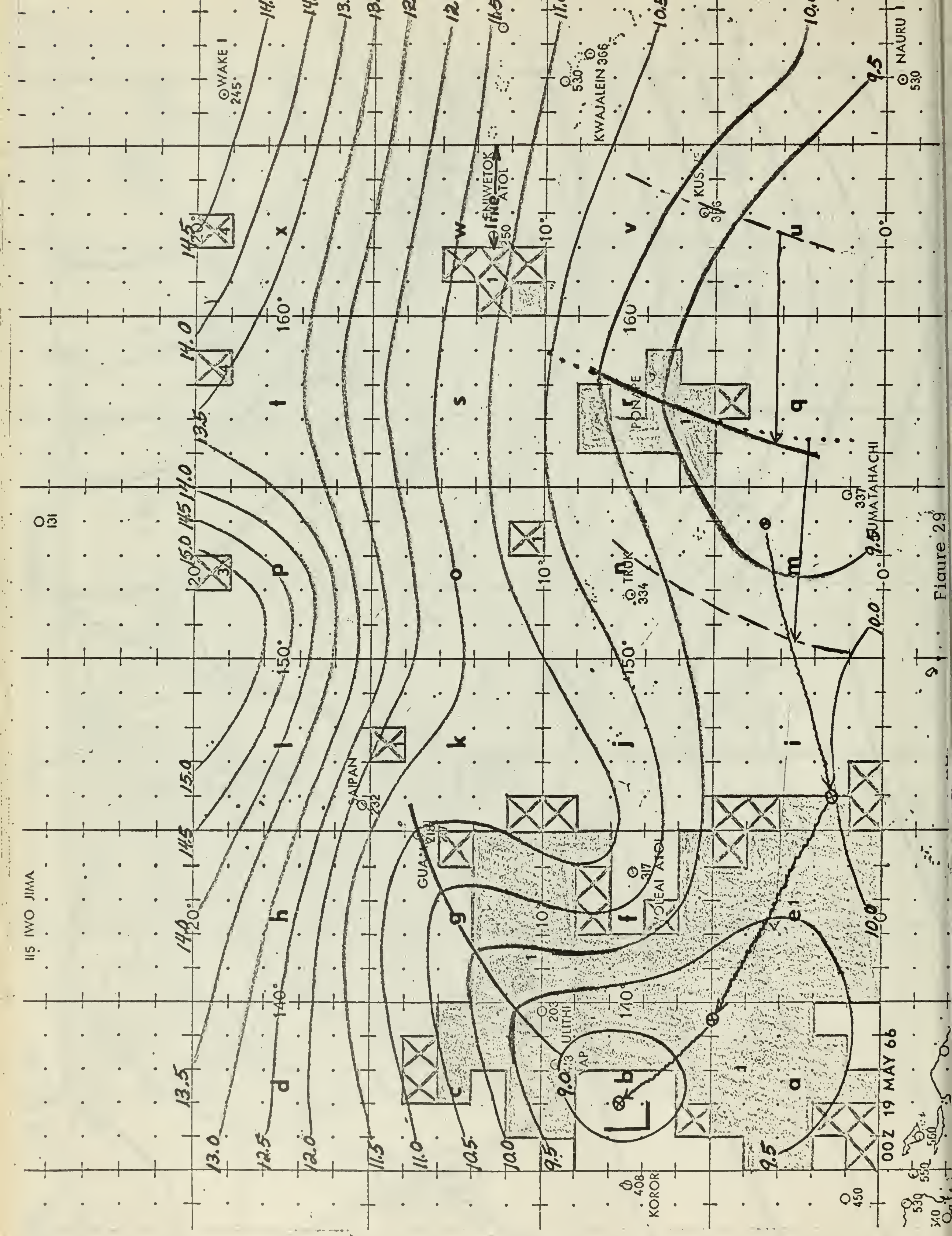

IWO JIMA
SAIPAN
282
GUAM
218
ULITHI
203
YAP
413
KOROR
408
WOLEAI ATOL
317
TRUK
334
PONAPE
348
KUSAIE
356
KWAJALE
ATOL
250
FUMATAHACHI
337
00 Z 19 MAY 66

Figure 28



115 IWO JIMA
WAKE I
245°
SAIPAN
ULITHI
KOROR
408
TRUK
334
PONAPE
KWAJALEIN 366
ENIWETOK ATOL
NAURU I
SUMATAHACHI
00Z 19 MAY 66

Figure 29

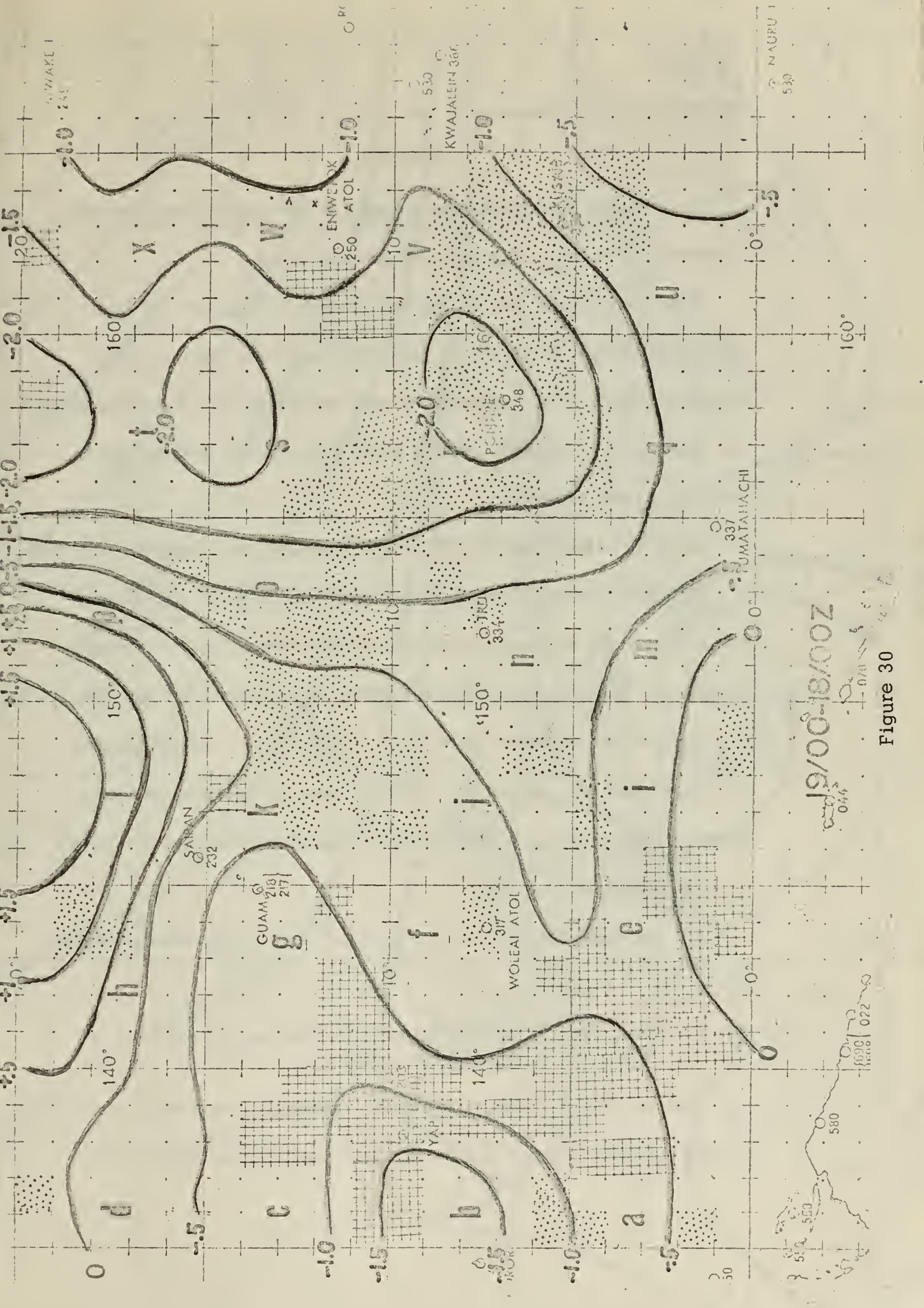

GUAM
SAIPAN
WOLEAI ATOL
YAP
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
KWAJALEIN
NAURU I
WAKE I
19/00-18/00Z

Figure 30

00Z 20 MAY 1966 (figures 31, 32, 33)

SURFACE

Only minor perturbations are found in the blocks where cloud increases have taken place in the past 24 hours.

The central pressure of the low located at 10N 135.5E has increased about 1.0 mb in the past 24 hours. The cloud mass associated with it has reduced in size but increased in organization. The system has evidently broken away from the ITC region and is travelling independently.

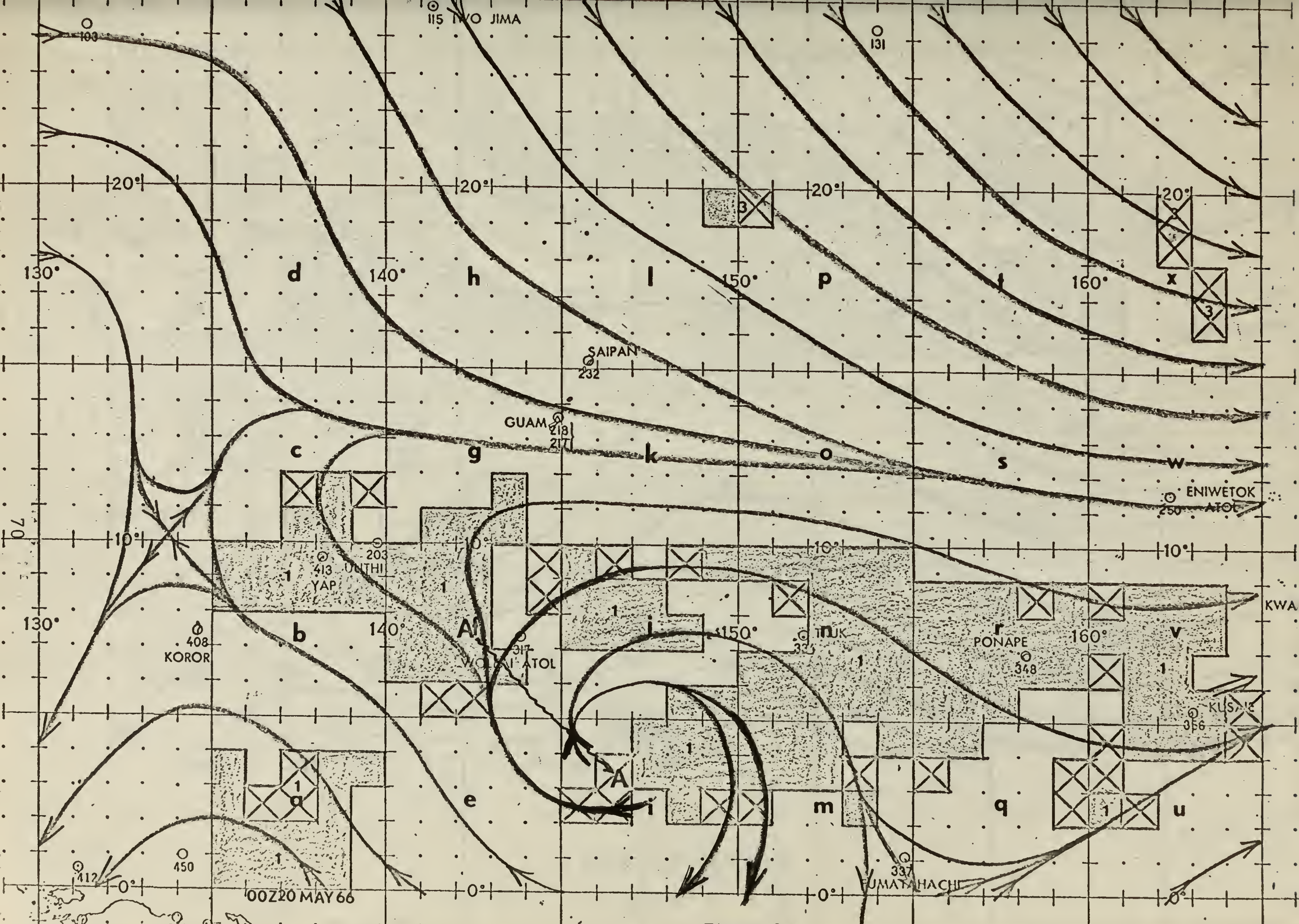
24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 20/00Z - 19/00Z

The large cloud increase areas in blocks j, i, n, m, q, r, u and v definitely are associated with the increased 250-mb lateral divergence in those areas since 19/00Z. This flow resulted from the tropical anticyclonic vortex at 7.5N 152.5E at 18/00Z moving southeastward to 3.5N 147E. Note the poor correlation between pressure decrease/increase and cloud increase/decrease in blocks n, r, m, and q at this time.

The positive isalloneph area in block a is due to cross-equator movement of a cloud mass.

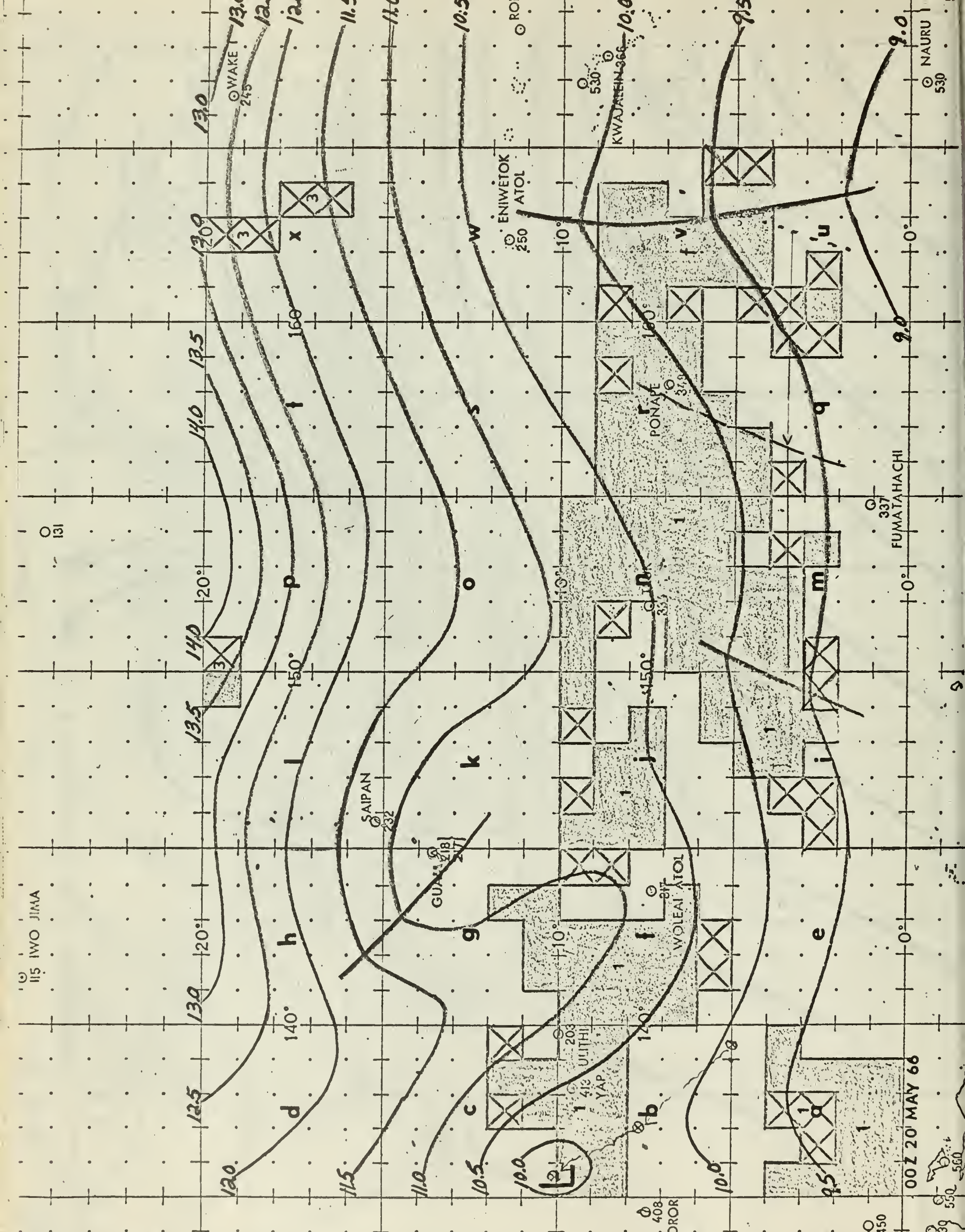
A Forecast of Clouds and Rainfall at Truk for the Period
20/00Z to 21/00Z

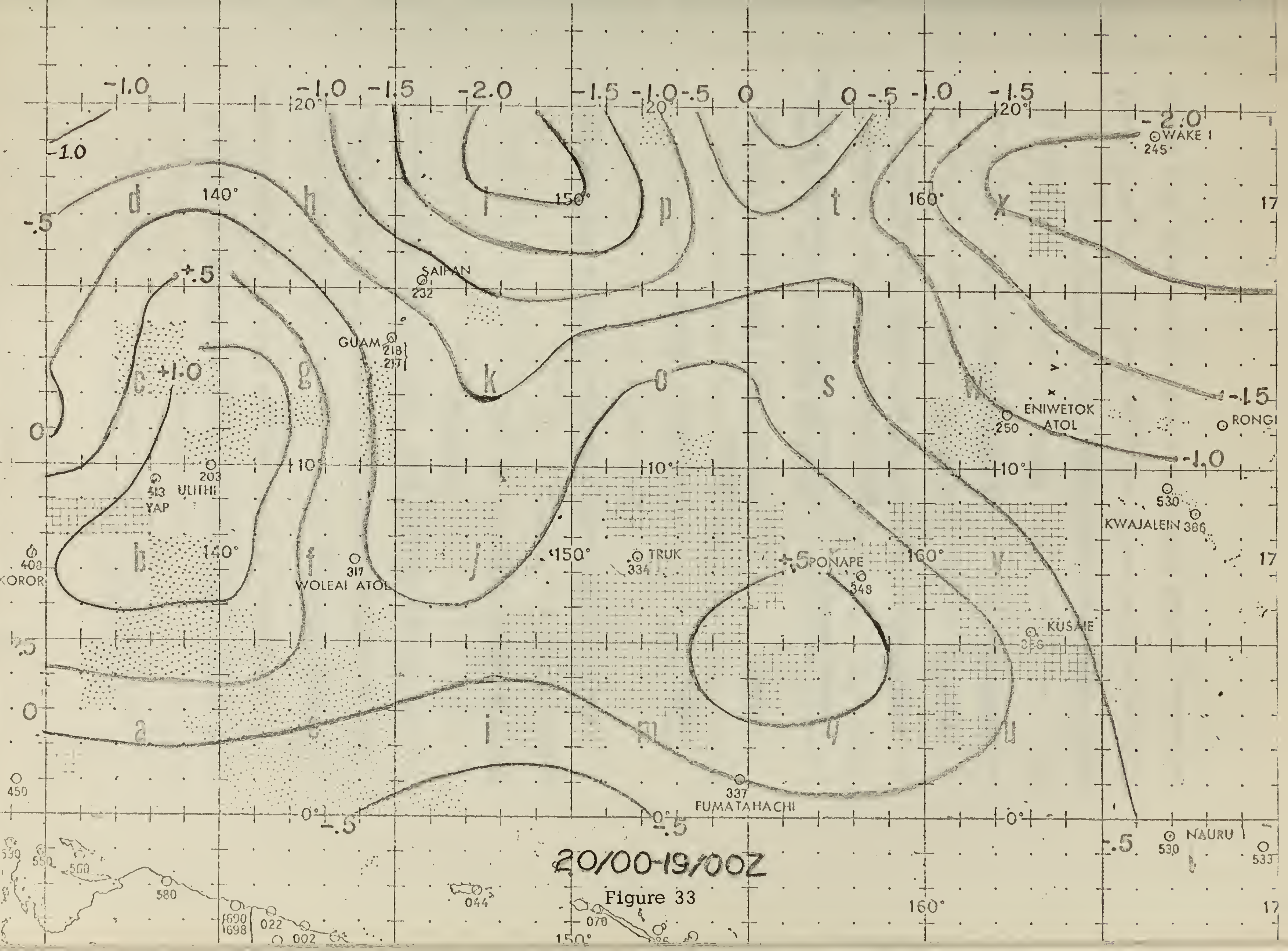
Truk is on the leading edge of an extensive cloud mass which is moving toward the west at 10 knots (the perturbation at 5N 150E,



115 IWO JIMA
131
103
20°
130°
140°
150°
160°
10°
0°
d
h
l
p
t
x
c
g
k
o
s
w
b
e
i
m
q
u
a
j
n
r
v
A
3
1
SAIPAN
232
GUAM
218
217
ENIWETOK
ATOL
250
413
YAP
203
ULITHI
408
KOROR
317
WOLEAI ATOL
TRUK
PONAPE
348
KUSAIE
356
KWA
337
UMATAHACHI
412
450
539
550
00Z20 MAY 66

Figure 31


00Z 20 MAY 66
IWO JIMA
WAKE I
ENIWETOK ATOL
KWAJALEIN
NAURU
SAIPAN
GUAM
WOLEAI ATOL
ULITHI
YAP
KOROR
PONAPE
FUMATAHACHI



20/00-19/00Z

Figure 33

associated with the cloud mass, is progressing westward at 17 knots).
Since the horizontal east to west dimension of the cloud mass is very large, shower activity was predicted for the whole period.

TABLE

Parameter	24-Hour Changes (20/00Z - 19/00Z)
pressure	increased 0.3 mb
temperature	increase near 6,000 and 30,000 feet and little change or slight falls elsewhere
isobaric heights	increases, with a small maximum at 34,000 feet except decreases below 23,000 feet
moisture	increased at all levels except near the surface
winds	insignificant changes

VERIFICATION

Excellent, shower activity prevailed throughout most of the period. Rainfall totaled 1.31 inches.

<u>00Z 21 MAY 1966</u> (figures 34, 35, 36)

UPPER AIR

A strong subtropical ridge has pushed into the northwestern portion of the area while a trough has moved into the central and northeastern sectors.

The combination of the two systems apparently caused the rather erratic 24-hour movement of the tropical anticyclonic vortex now at 2N 145E.

SURFACE

The low at 10N 135.5E at 20/00Z is located 80 nm west of block c. The cloud masses in blocks northern b, c, d, g, southwestern h and k appear to be organizing into bands leading into this low. The central pressure has dropped at least 1.0 mb in the past 24 hours. This low which subsequently obtained tropical depression characteristics was not carried on an operational surface chart at 21/00Z. Later operational surface charts and APT photographs show it merging with a stationary front far to the northwest of the area at 23/00Z.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 21/00Z - 20/00Z

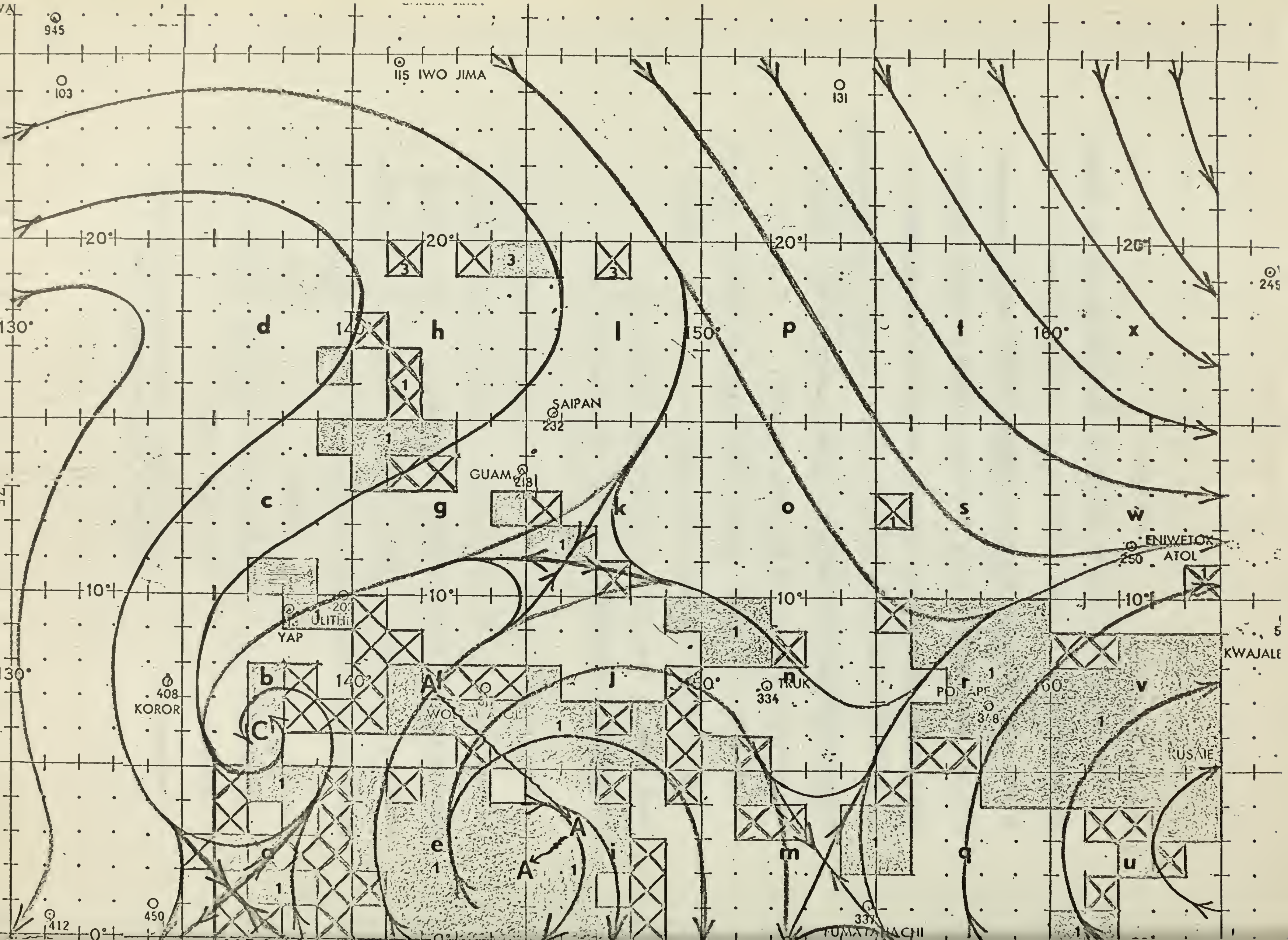
The increases of cloud in southern block e are due to a cloud mass movement north of the equator in the past 24 hours.

Forecast for Clouds and Rainfall at Truk for the Period 21/00Z to 22/00Z

The 24-hour isalloneph/isallobaric chart aids in determining that the cloud mass east of 156E is associated with the trough oriented north/south along 163E at 20/00Z. This cloud mass has moved west northwest at 7.5 knots. Since it is 250 nm east southeast of Truk no shower activity was predicted for the period 21/00Z to 22/00Z.

TABLE

Parameter	24-Hour Changes (21/00Z - 20/00Z)
pressure	increased 0.3 mb
temperature	increases near the tropopause with little changes or slight falls elsewhere


IWO JIMA
SAIPAN
GUAM
ULITHI
YAP
KOROR
TRUK
ENIWETOK ATOL
KWAJALEI
KUSAIE

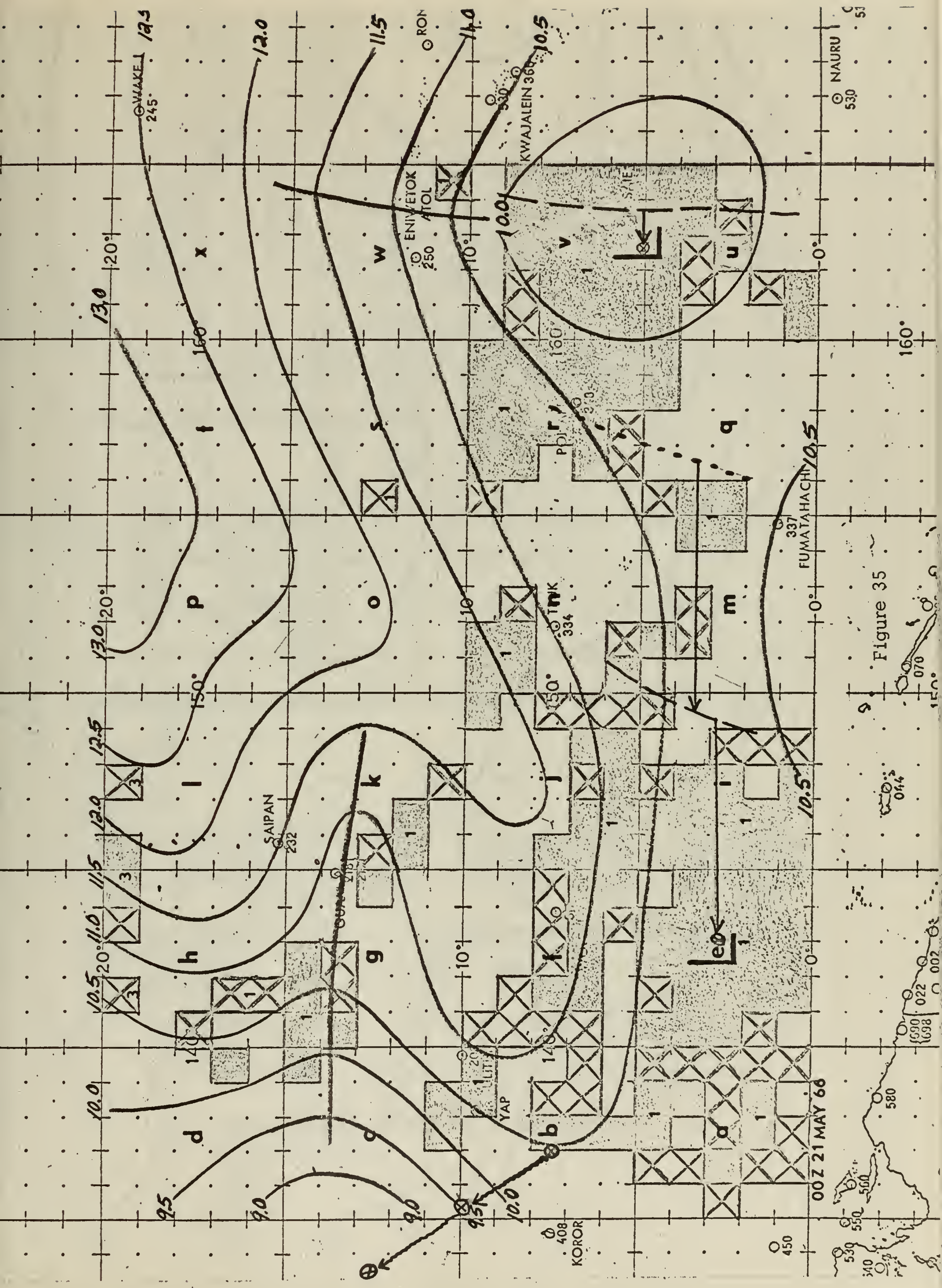
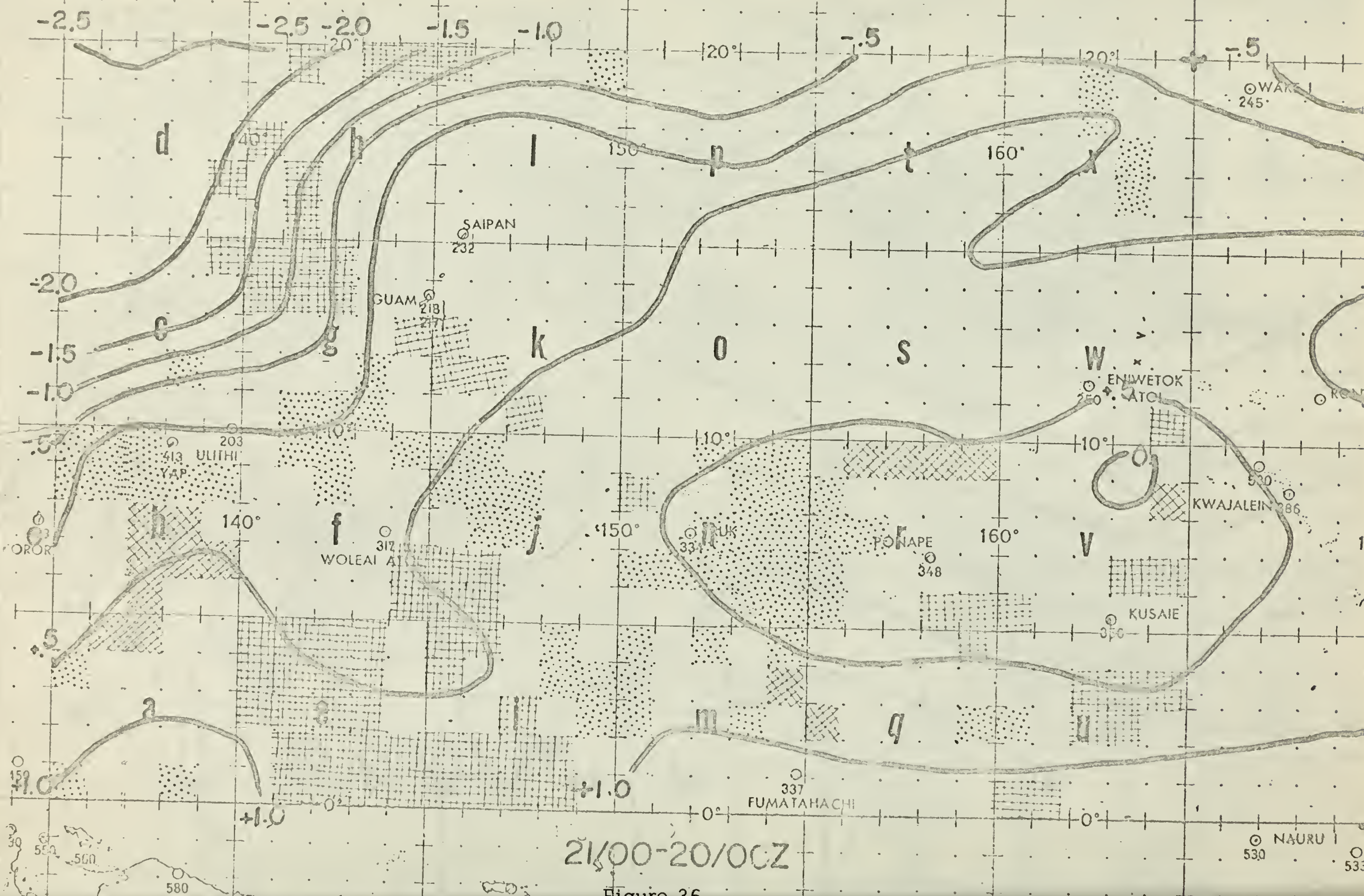

00Z 21 MAY 68
WAKE
245
SAIPAN
232
ENIWETOK ATOL
250
KWAJALEIN 368
NAURU
530
TRUK
334
FUMATAHACHI
337
YAP
KOROR
408
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0

Figure 35



-2.5
-2.0
-1.5
-1.0
-.5
.5
+1.0
-.5
-1.0
-1.5
-2.0
-2.5
20°
10°
0°
140°
150°
160°
SAIPAN
232
GUAM
218
ULITHI
203
YAP
413
WOLEAI
312
TRUK
PONAPE
348
ENIWETOK ATOLL
KWAJALEIN
KUSAIE
WAKE
245
NAURU
530
533
FUMATAHACHI
337
580
044
a b c d f g h j k l m n o p q r s t u v w x
21/00-20/00Z

Figure 36

isobaric heights	decreases at all levels with a 40-meter change from 35,000 to 50,000 feet
winds	easterlies veered above 5,000 feet and backed below
moisture	little change

VERIFICATION

Excellent; no rainfall occurred at the station during the period.

<u>00Z 22 MAY 1966</u> (figures 37, 38, 39)

UPPER AIR

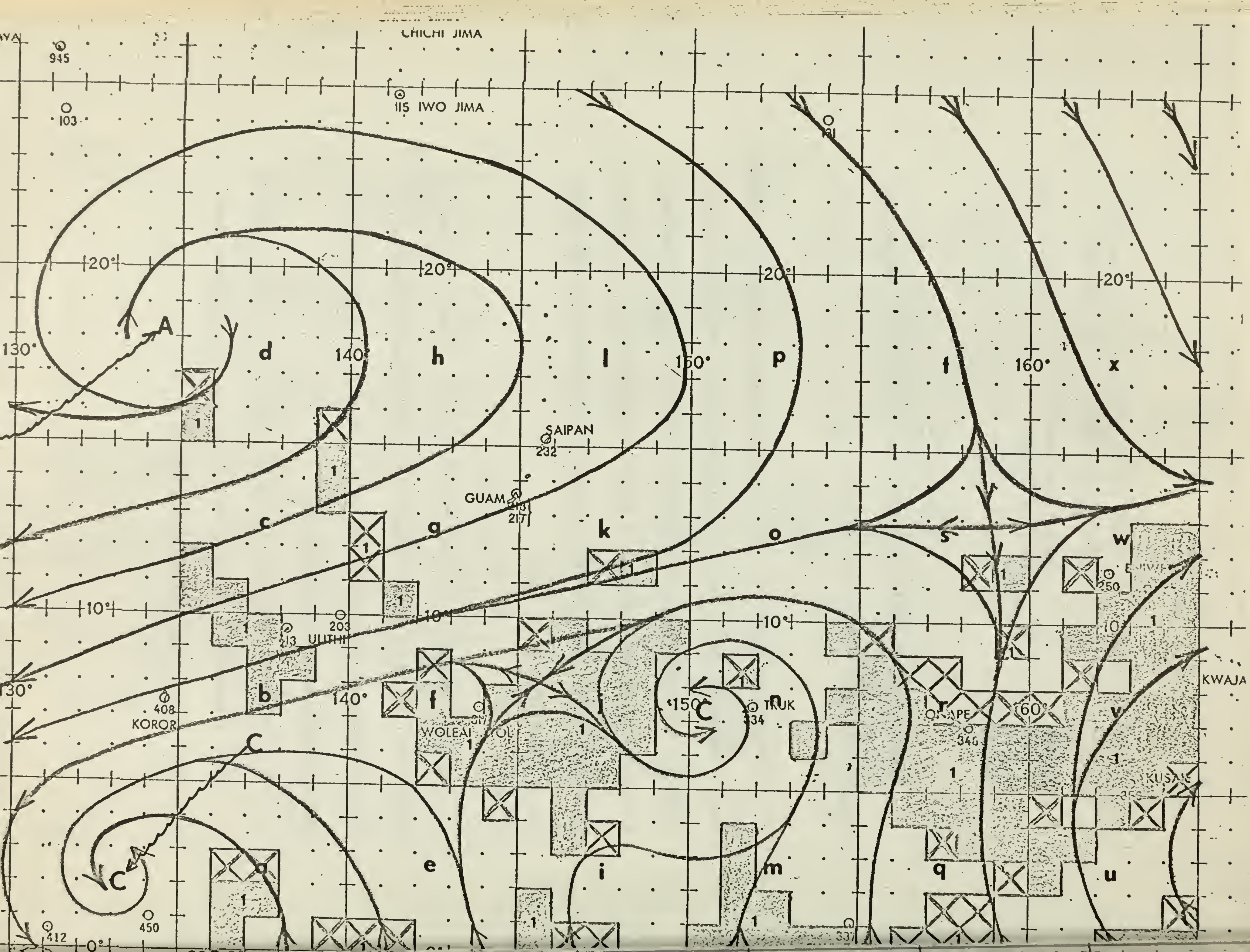
The cyclonic vortex at 7.5N 150.5E was generated at the southern end of the trough mentioned at 21/00Z (See Truk's cross section for thermal characteristics). The vortex at 2.0N 133.5 was generated at 21/00Z in the same manner as above. The cloud mass in the blocks traversed by this latter vortex decreased considerably in size during the period 21/00Z to 22/00Z.

SURFACE

The low, dubiously located at 2.5N 144E at 21/00Z, is now at 6.0N 148E. Once again the cloud mass has decreased slightly in size but increased in organization while the central pressure of the low has fallen in the past 24 hours.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 22/00Z - 21/00Z

Cloud increases in block m are due to cross-equator movement of a cloud mass during the period 21/00Z to 22/00Z.



CHICHI JIMA
IWO JIMA
SAIPAN
GUAM
ULITHI
KOROR
WOLEAI
TRUK
PONAPE
KUSAIE
KWAJA

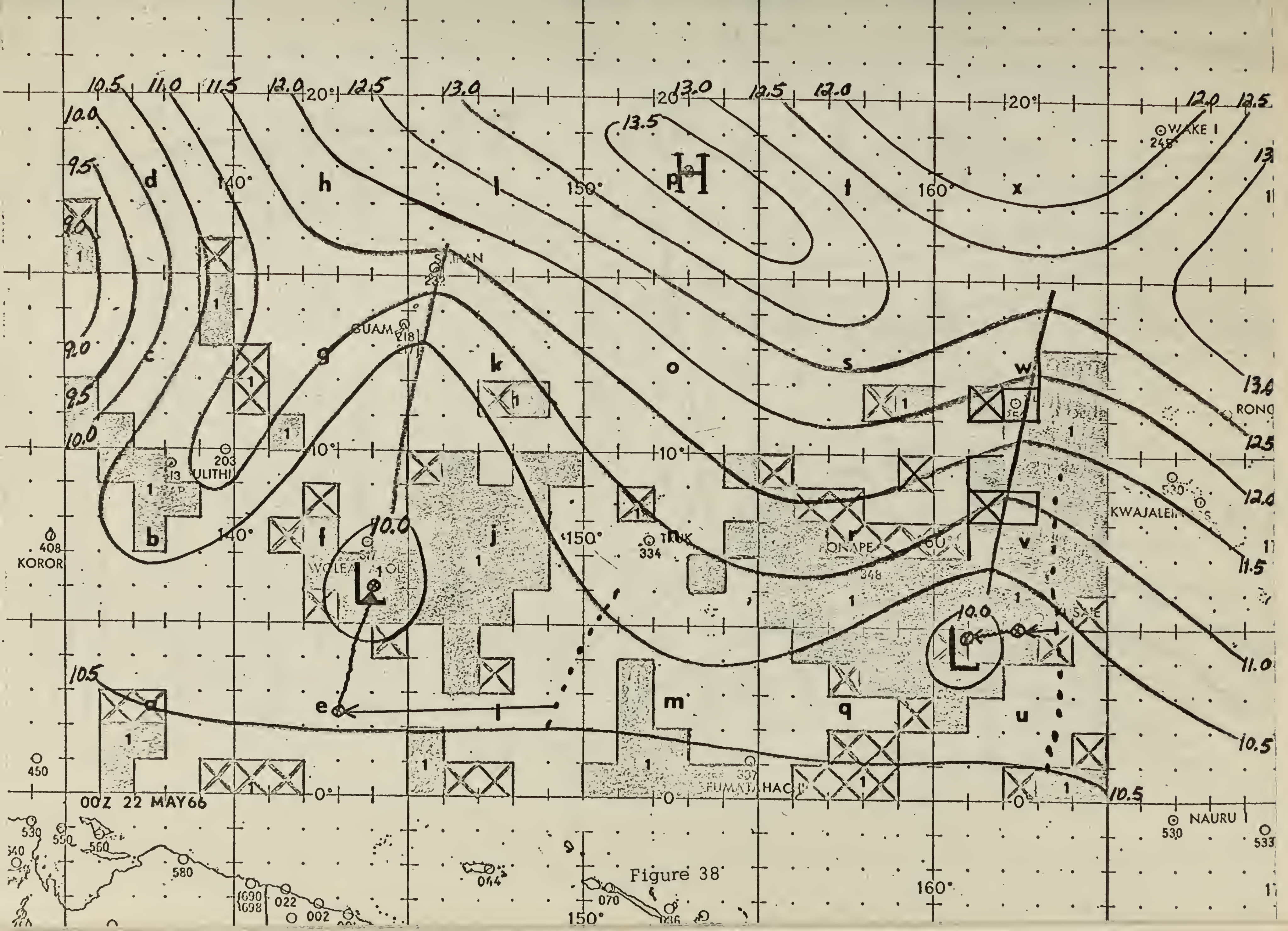
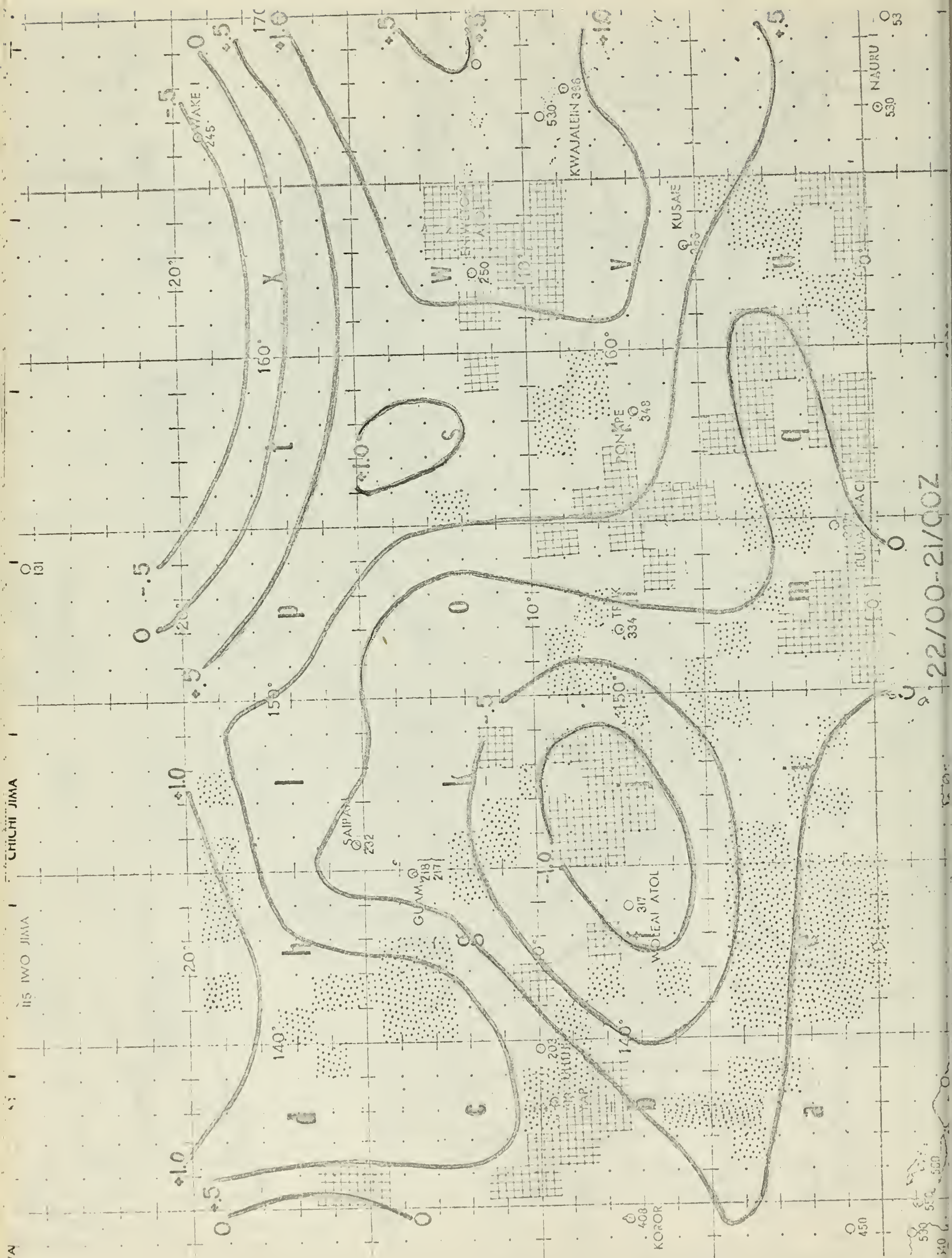

00Z 22 MAY66
WAKE I
RONG
KWAJALEIN
NAURU
GUAM
TRUK
PONAPE
ULITHI
KOROR
WOLEAI ATOL
KUSAIE
FUMATAHAC

Figure 38


CHICHI JIMA
IWO JIMA
WAKE I
KWAJALEIN
NAURU
KUSAIE
PONAPE
TRUK
SAIPAN
GUAM
WOLEAI ATOL
YAP
KOROR
22/00-21/00Z

00Z 23 MAY 1966 (figures 40, 41, 42)

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 23/00Z - 22/00Z AND SURFACE CHART

A large portion of the experiment area shows cloud decreases which coincide very well with the increased cyclonic flow at 250-mb during the period 22/00Z to 23/00Z.

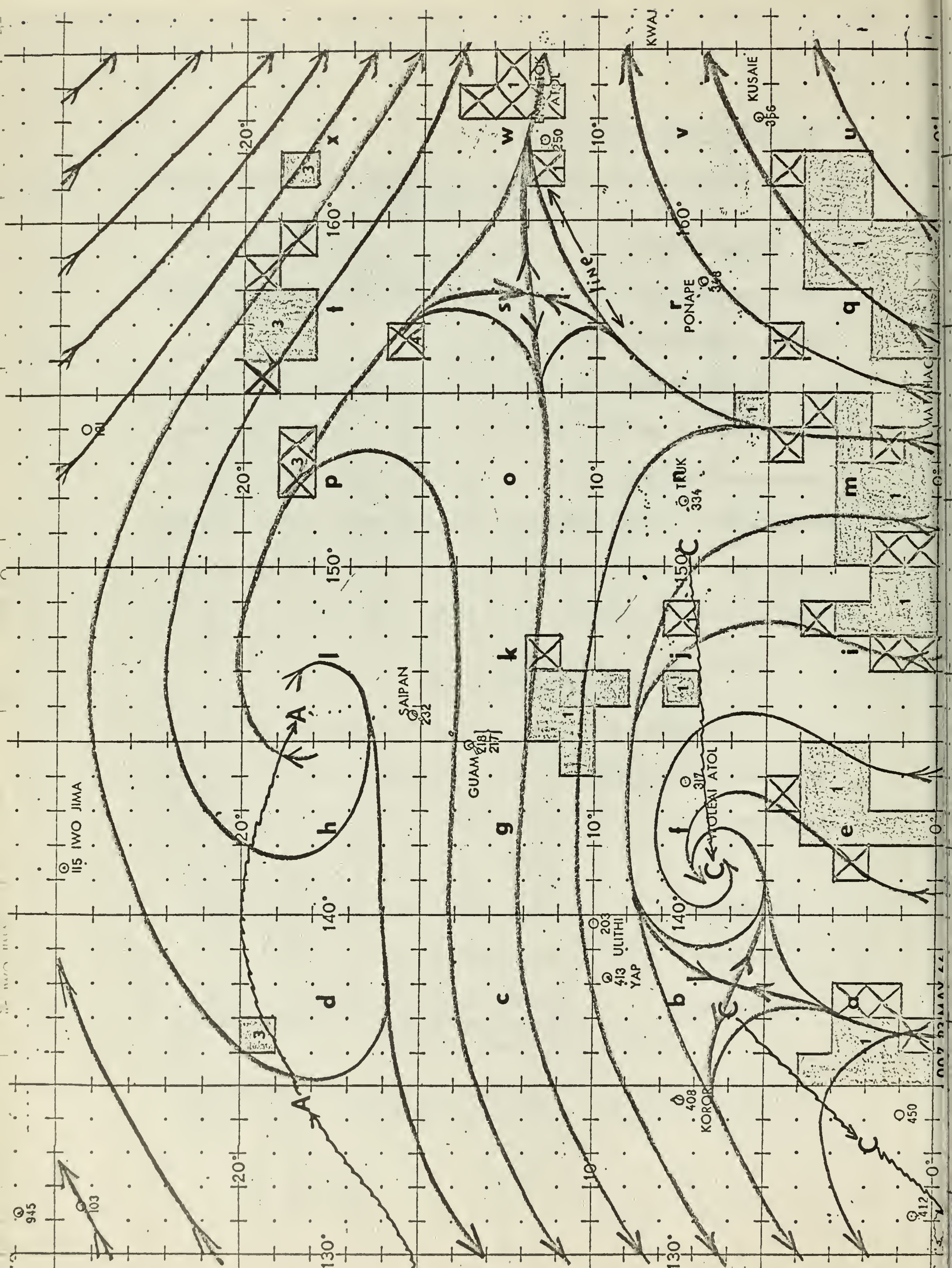
The slow moving low at 4.5N 161E at 21/00Z accelerated to the west southwest and is located at 4N 157.5E at 23/00Z. The cloud mass associated with this low has decreased north of the center. A perturbation has developed west of this low center. The cloud mass assoicated with it is found from the 24-hour isalloneph/isallobaric chart and cloud break area to be in blocks i, m and n.

Forecast of Clouds and Rainfall at Guam for the Period 23/00Z to 24/00Z

The cloud mass 90 nm south of Guam is moving northward at 5.2 kt. Since its latitudinal dimension is 120 nm, shower activity was predicted to begin at 23/18Z and continue to the end of the period.

TABLE

Parameter	24-Hour Changes (22/00Z - 21/00Z)
pressure	increased 0.2 mb
temperature	strong increases at 45,000 feet and decreases near the tropopause. Small changes elsewhere
isobaric heights	decreases becoming more pronounced toward the tropopause



IWO JIMA
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
KWAJ
line

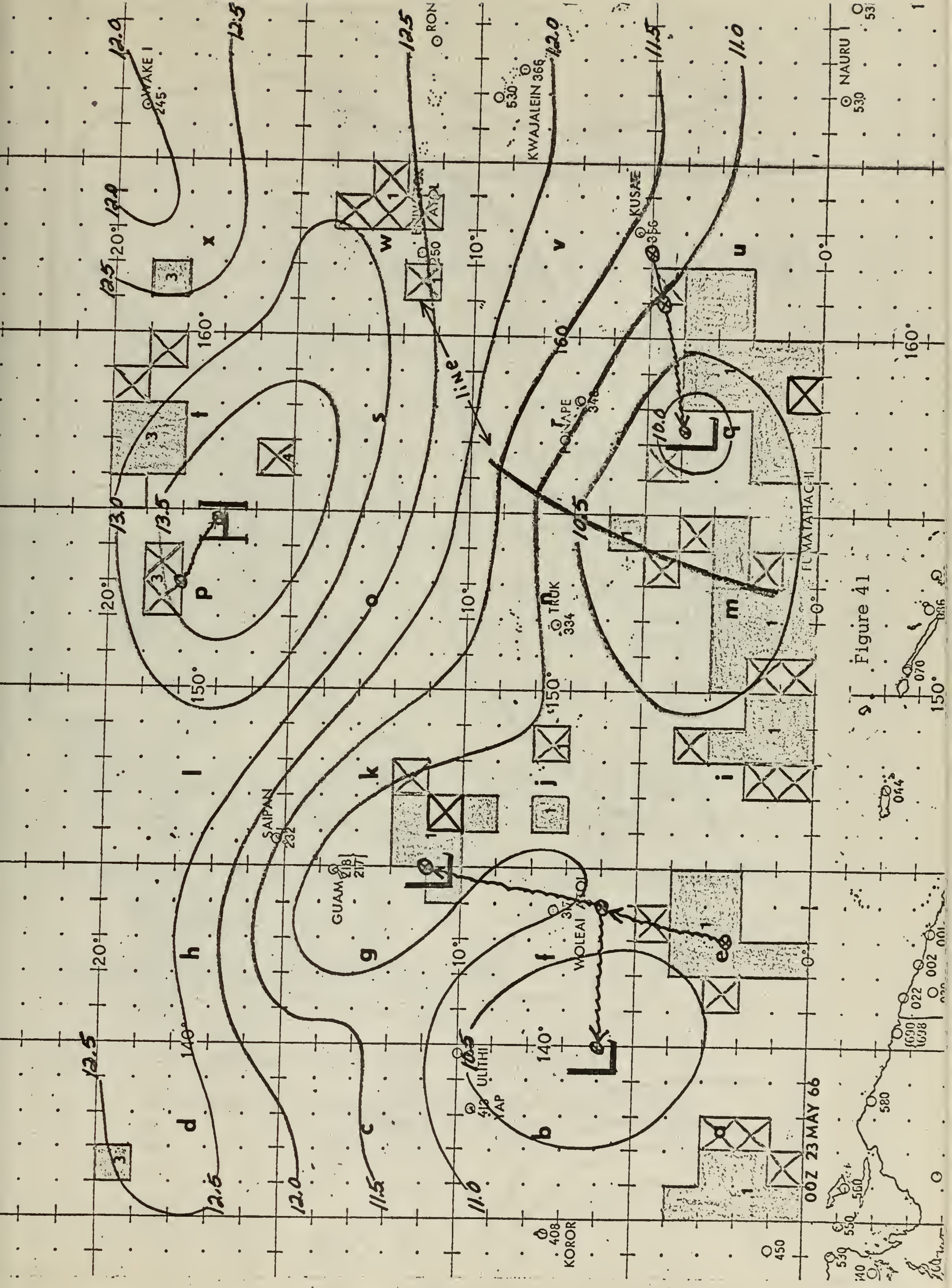
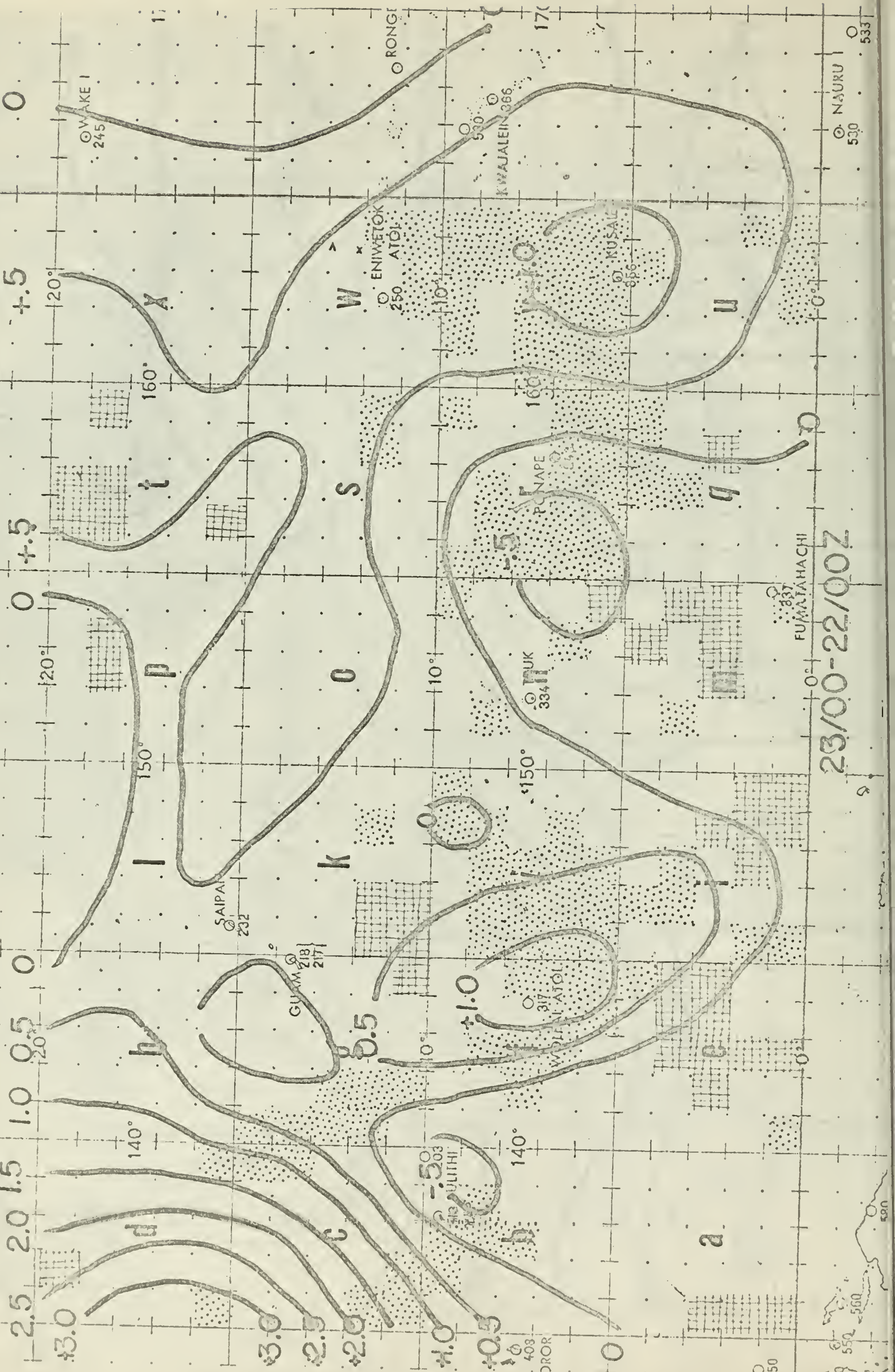

00Z 23 MAY 66
WAKE I
KWAJALEIN 366
NAURU
KUSAIE
PONAPE
TRUK
334
SAIPAN
232
GUAM
WOLEAI
ULITHI
YAP
KOROR
408
line
12.0
12.5
13.0
13.5
11.5
11.0
10.5
10.0

Figure 41



23/00-22/00Z
WAKE I
ENIWETOK ATOL
KWAJALEIN
KUSAIE
NAURU
PONAPE
TRUK
SAIPAN
GUAM
WOLEAI ATOL
ULITHI

moisture	little change
winds	easterlies backed slightly at all levels

VERIFICATION

Good; several showers occurred prior to 23/20Z while 0.20 inches of the total 0.23 inches fell after this time.

<u>00Z 24 MAY 1966</u> (figures 43, 44, 45)

UPPER AIR

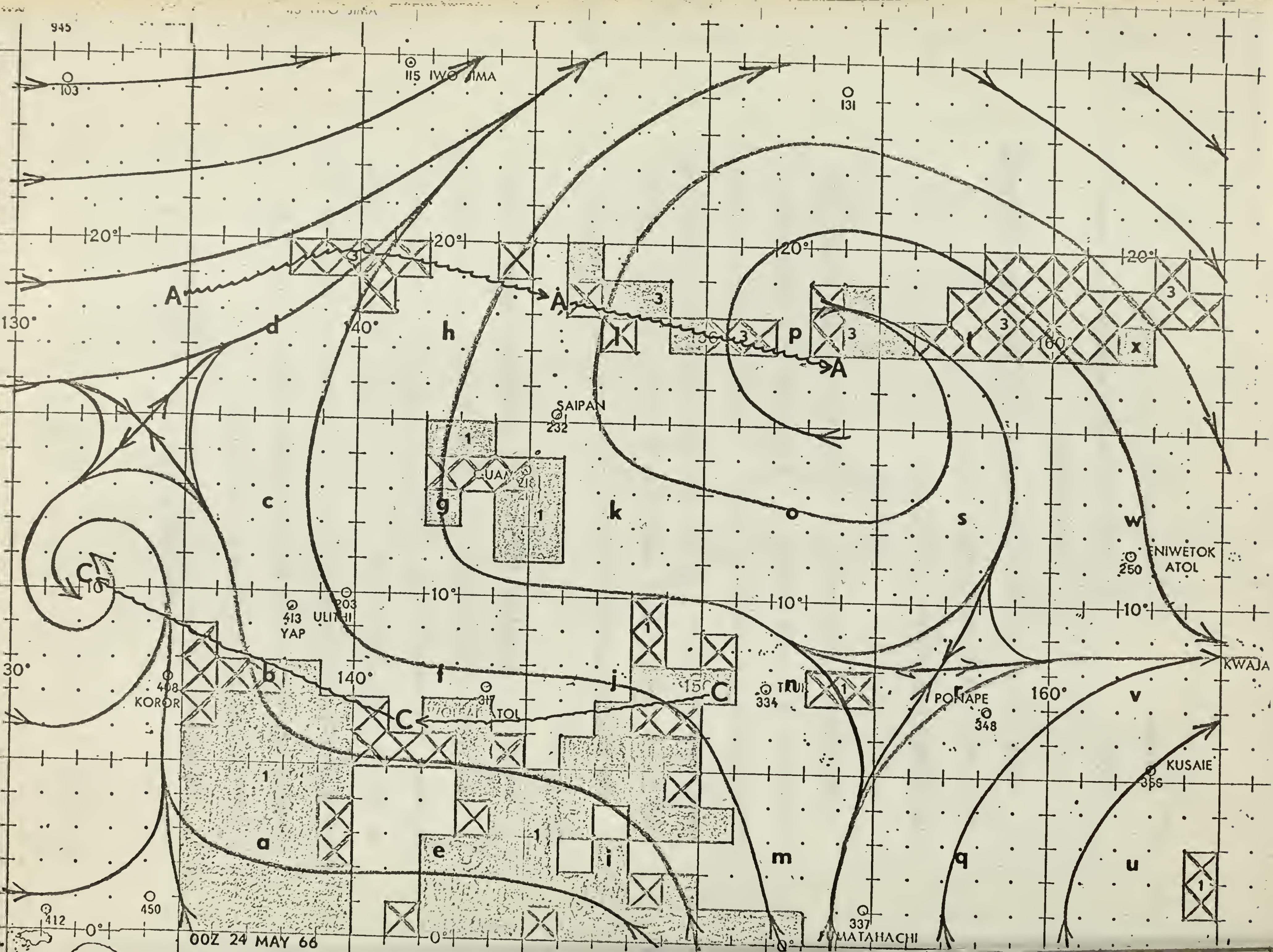
The cyclonic vortex at 10.5N 132E has moved quite rapidly west northwest. By looking at figure 9 it is seen that this vortex moves to the southeast of Manila by 25/00Z. It is believed that this vortex transformed into a warm core low that helped to generate Typhoon Judy. Judy reached tropical storm strength in the interval 25/00Z to 26/00Z.

The subtropical high at 17N 154E has ridged southwestward to the equator.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 24/00Z - 23/00Z

The cloud increases in blocks a and b correlate very well with the decrease in pressure in that area due to the cloudless low at 23/00Z at 6N 140E moving to 6N 136E. Note that the cloudless low at 23/00Z could possibly have developed from the downward penetration of positive vorticity from the 250-mb cyclonic vortex at 5.5N 141.5E at 23/00Z moving to 10.5N 132.5E at 24/00Z.

A Forecast of Clouds and Rainfall at Truk for the Period
24/00Z to 25/00Z



945
103
115 IWO JIMA
131
SAIPAN
232
218
413
YAP
ULITHI
203
408
KOROR
317
ATOL
334
348
PONAPE
250
ENIWETOK
ATOL
KWAJA
KUSAIE
337
412
450
00Z 24 MAY 66

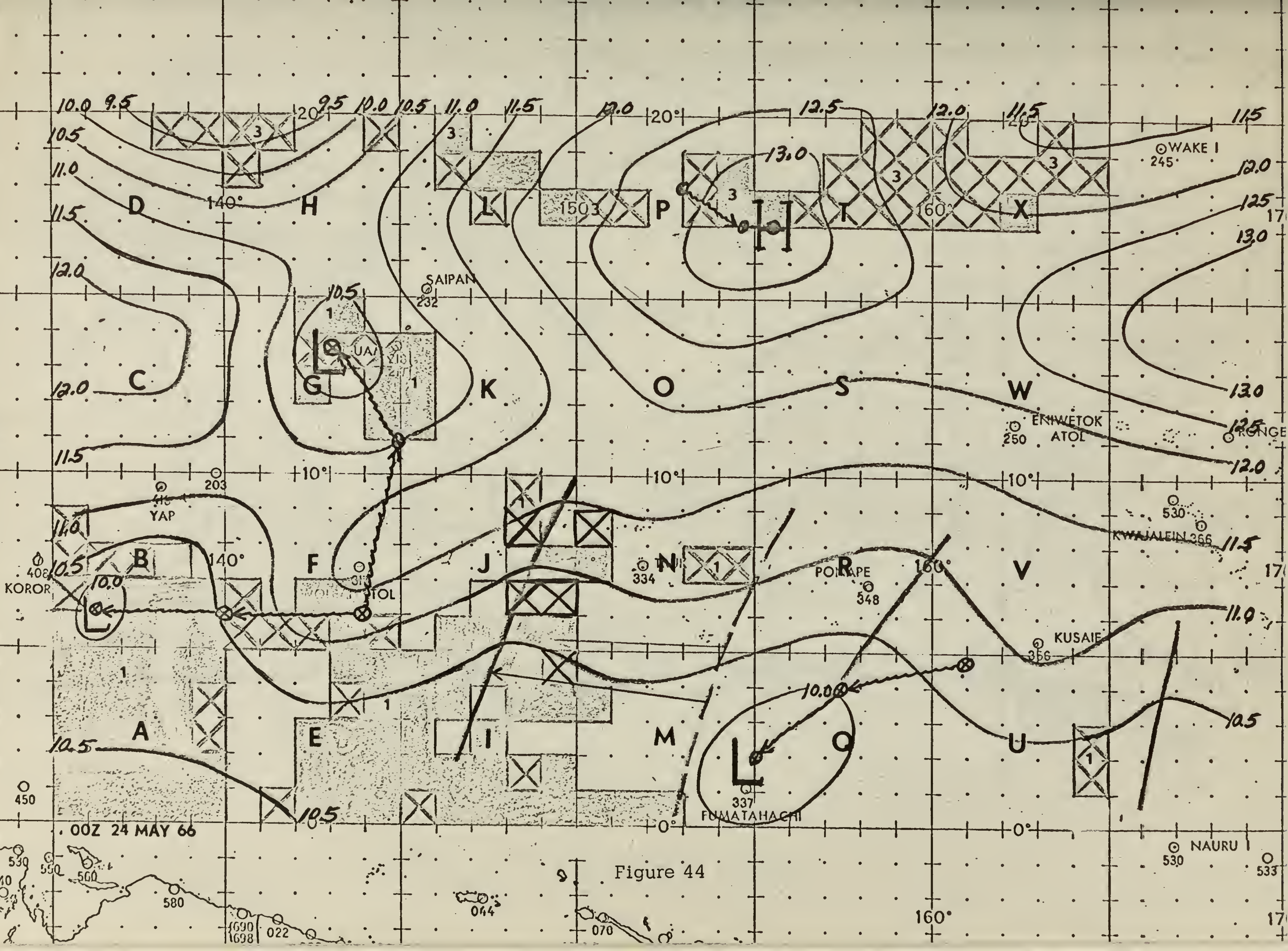
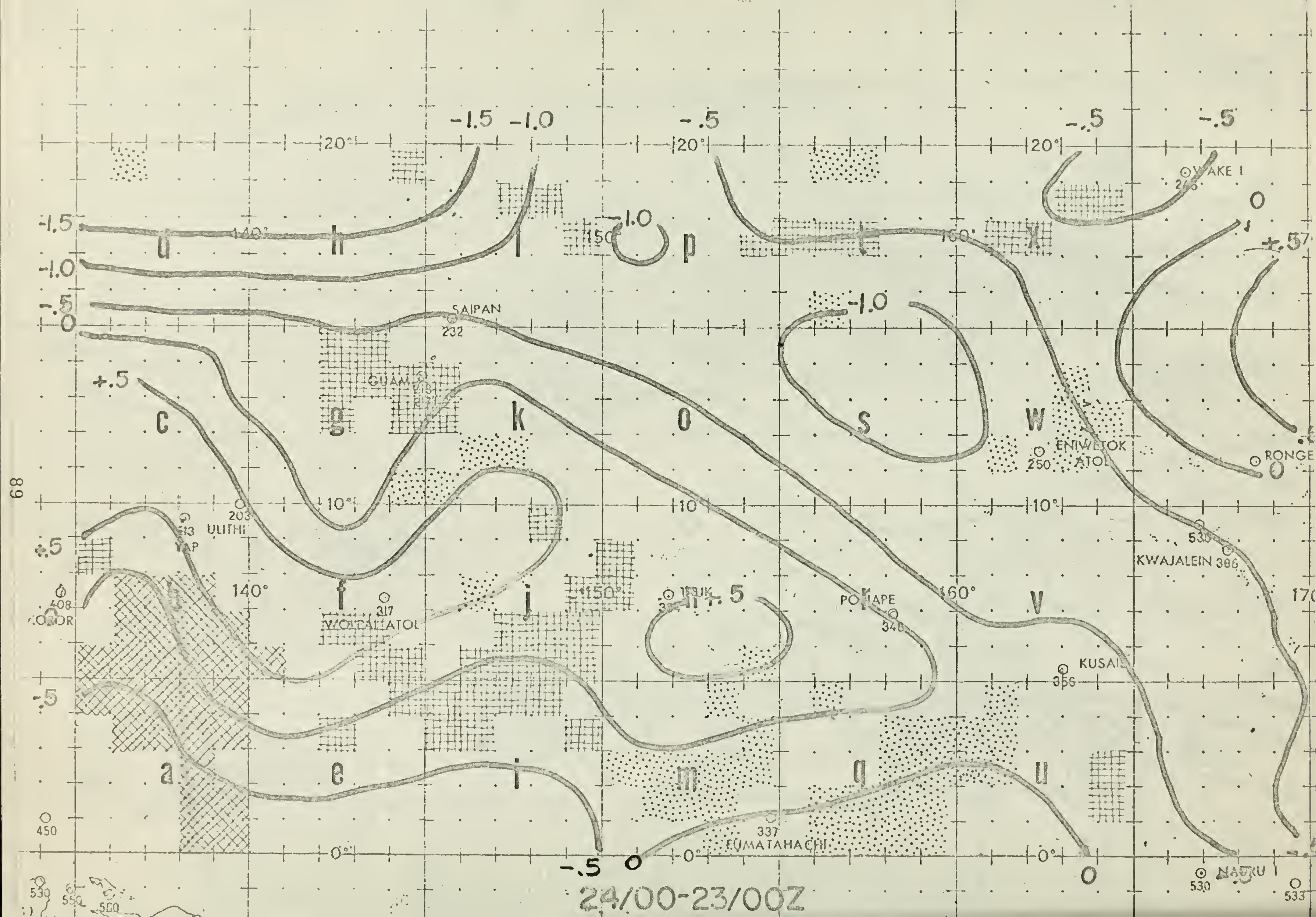

WAKE I
SAIPAN
YAP
KOROR
ENIWETOK ATOL
KWAJALEIN
PONAPE
KUSAIE
NAURU
FUMATAHACHI
00Z 24 MAY 66

Figure 44


SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
KWAJALEIN
ENIWETOK ATOL
WAKE I
RONGE
NAURU
FUMATAHACHI
24/00-23/00Z

A cloud mass, 120 nm wide (east to west) located 70 nm east of Truk, developed in situ during the period 23/00Z to 24/00Z. Note the lateral divergent flow east of Truk at 23/00Z at 250 mb. The velocity of the downstream trough is westward at 15 knots and is used to estimate the velocity of the cloud mass. Therefore, shower activity is forecast from 24/06Z to 24/14Z.

TABLE

Parameter	24-Hour Changes (24/00Z - 23/00Z)
pressure	no change
temperature	little change except slight increases near the tropopause
isobaric height	slight increases except larger increases near the tropopause
winds	light easterlies backed slightly
moisture	slight decreases except increases near the surface

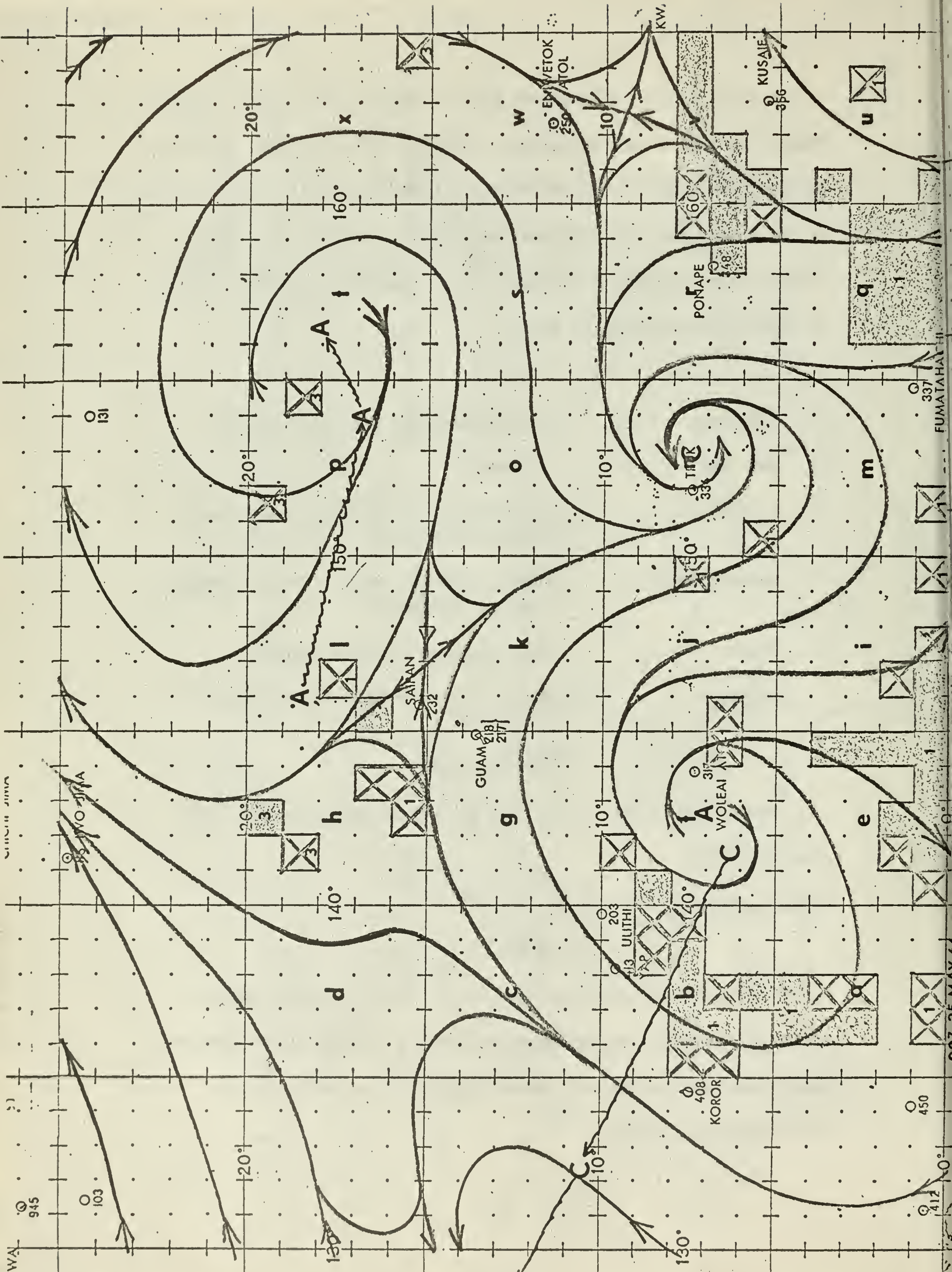
VERIFICATION

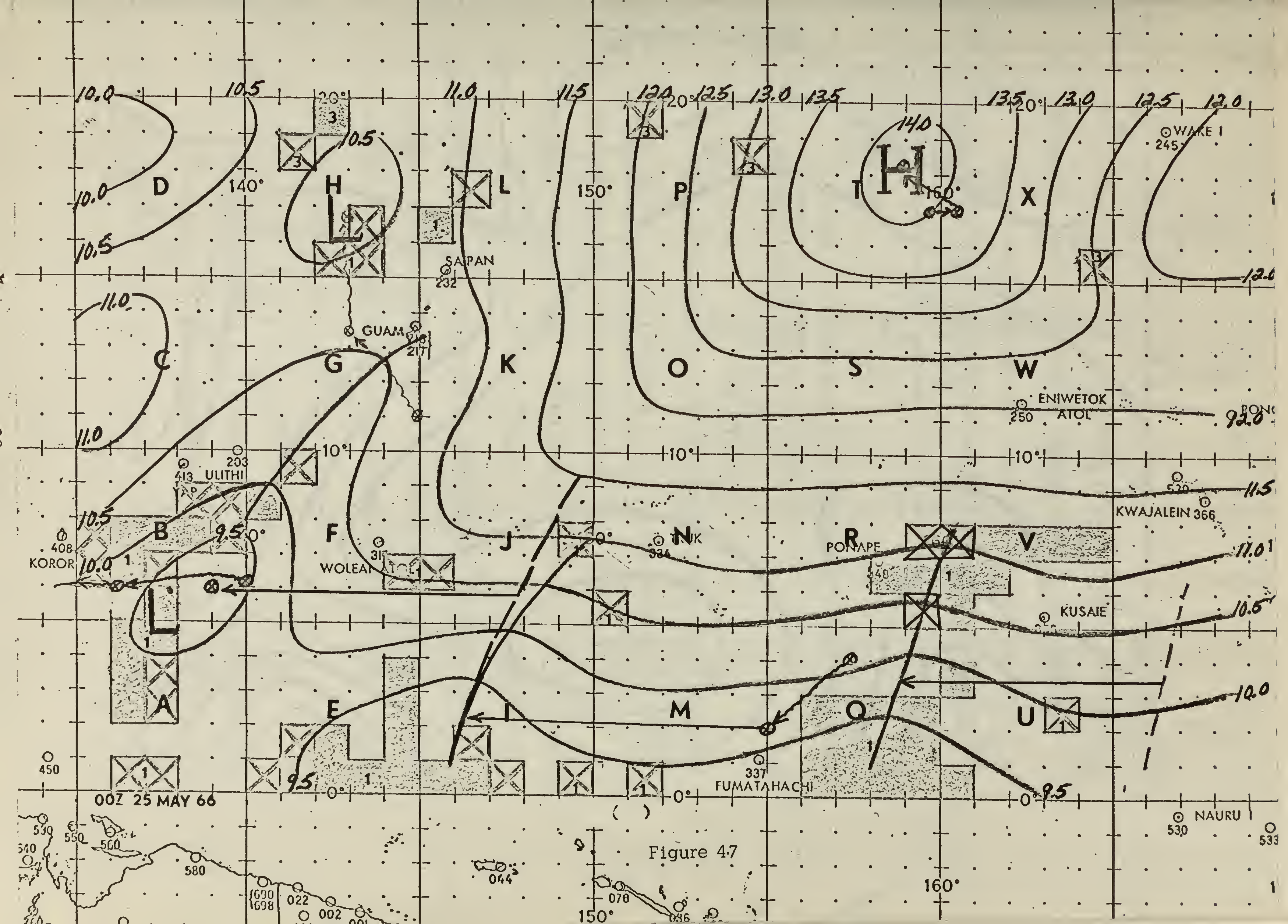
Good; 0.47 inches of the total of 0.48 inches of rainfall fell around 24/10Z.

00Z 25 MAY 1966 (figures 46, 47, 48)

UPPER AIR

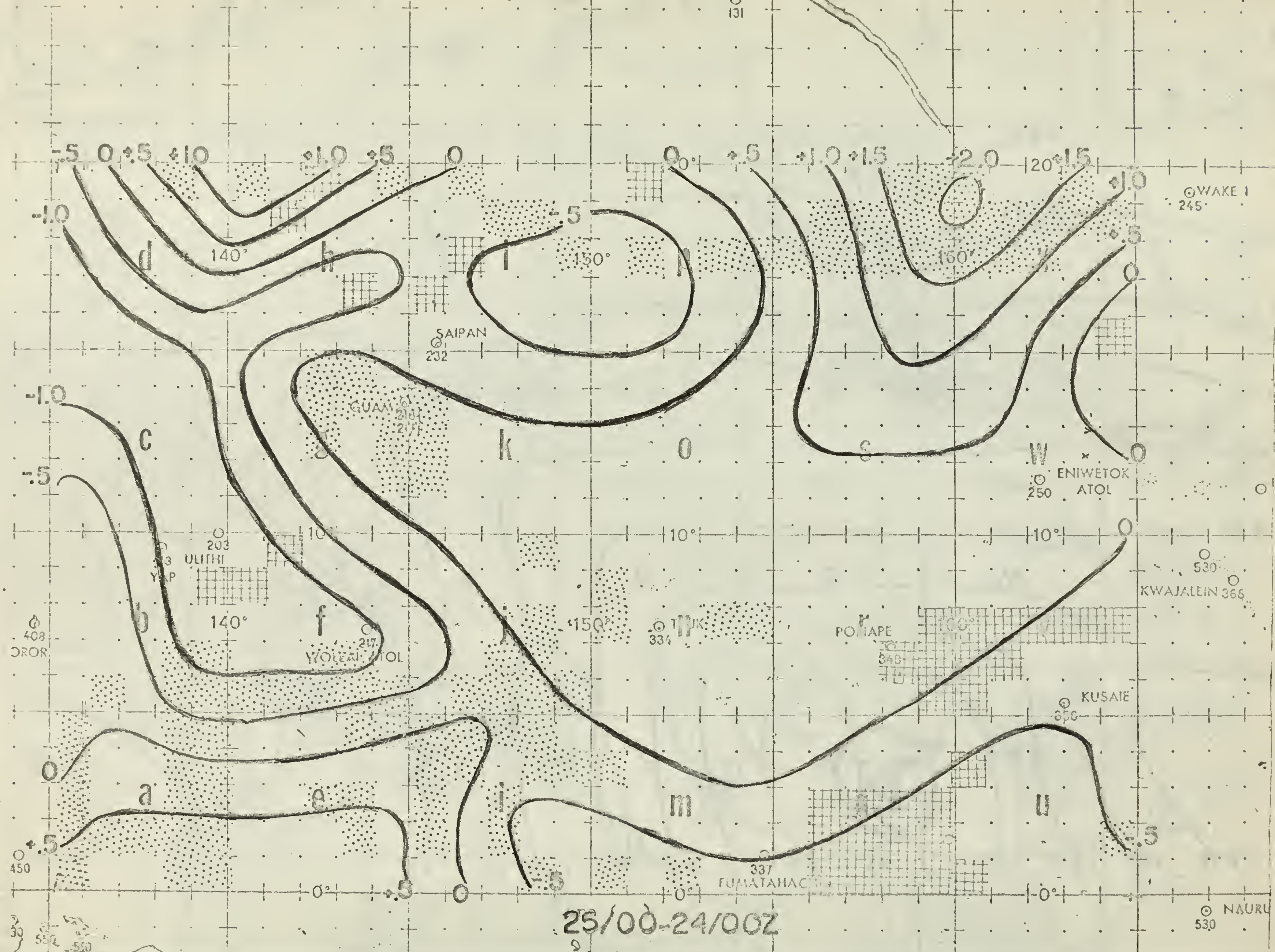
The tropical anticyclonic vortex at 7N 152.5E first appeared at 24/12Z (figure 9) as the result of an eddy breaking away from the subtropical high which had ridged equatorward as noted in the discussion at 24/00Z.


IWO JIMA
SAIPAN
GUAM
ULITHI
KOROR
WOLEAI
TRUK
PONAPE
KUSAIE
ENIWETOK ATOLL
KW.



00Z 25 MAY 66
WAKE I
ENIWETOK ATOL
KWAJALEIN
KUSAIE
PONAPE
FUMATAHACHI
NAURU
GUAM
SAIPAN
ULITHI
KOROR
WOLEAI ATOL

Figure 4·7



WAKE I
245
ENIWETOK ATOL
250
KWAJALEIN 366
530
KUSAIE
NAURU
530
SAIPAN
232
GUAM
ULITHI
203
YAP
WOLEAI ATOL
217
PONAPE
348
FUMATAHAC
337
OROR
408
450
580
140°
150°
160°
10°
20°
0°
-1.0
-.5
0
+.5
+1.0
+1.5
+2.0
a
b
c
d
e
f
h
i
j
k
l
m
o
p
q
r
s
u
w
25/00-24/00Z

Figure 48

A cyclonic vortex east of Truk formed close to 3N 156E at 24/12Z at the western end of a nearly zonally oriented trough. Evidence of this trough is still noticeable at 25/00Z southeast of Eniwetok.

The subtropical high at 18N 156.5E has been the dominating feature north of 15N for the past several days and a quick glance at figures 37, 40 and 43 confirms that it is generally free of a type 1 cloud mass.

In general, the systems are weak and moving rapidly westward.

00Z 26 MAY 1966 (figures 49, 50, 51)

UPPER AIR

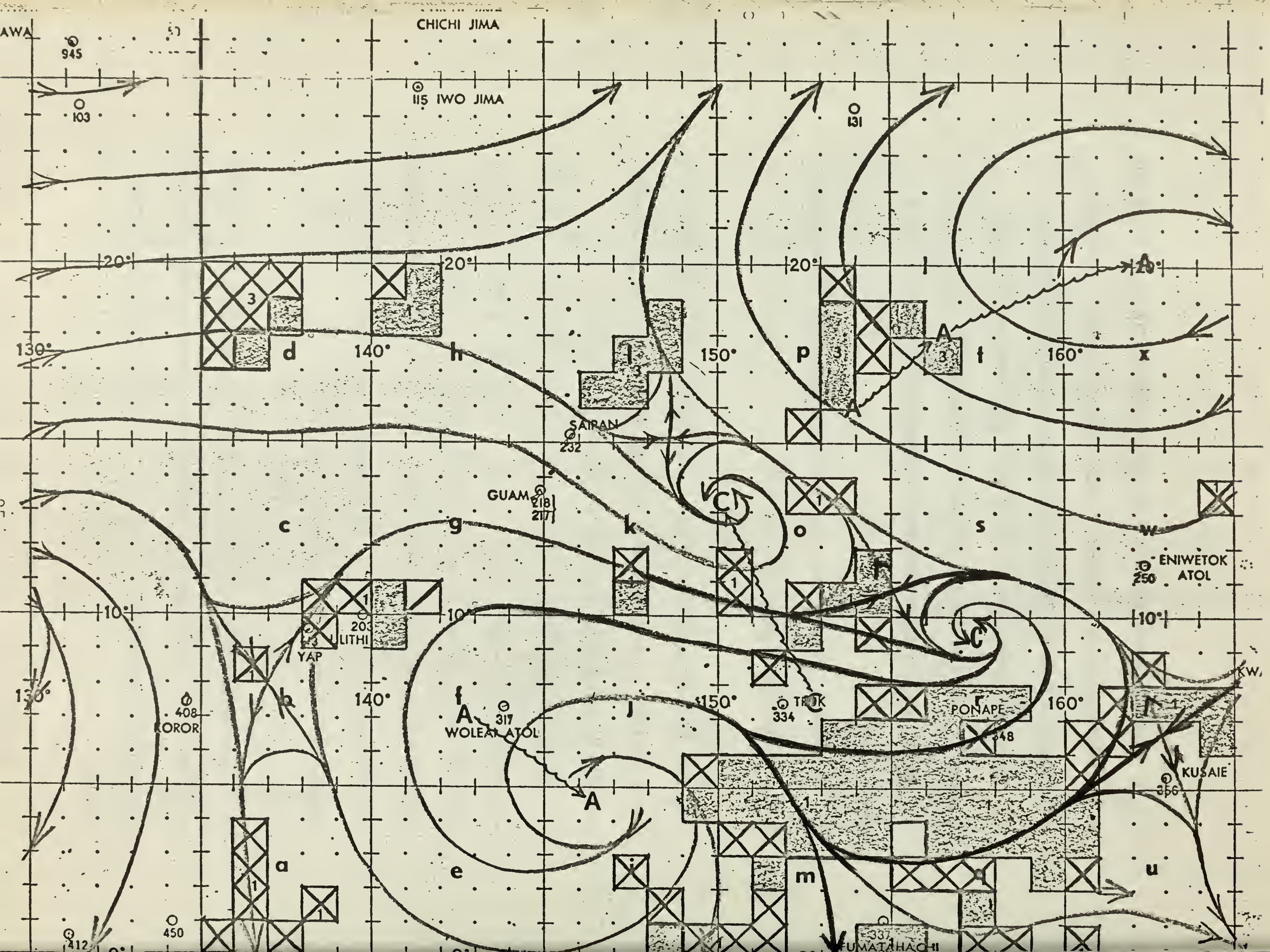
The cyclonic vortex at 9.5N 157.5E formed near 7.5N 162E at about 25/12Z. It was generated from the western end of the zonally oriented trough in that area and mentioned at 25/00Z.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 26/00Z - 25/00Z

Increases in cloud cover in blocks n, m, r and q appear to be aided by the increased lateral divergent flow at 250 mb in those regions during the period 25/00Z to 26/00Z. This flow was associated with the tropical anticyclonic vortex that developed on 25/00Z and moved southeastward to 4.5N 146.5E at 26/00Z.

SURFACE

A low center at 3N 153E developed during the period from 25/00Z to 26/00Z out of the trough located in blocks q and r at 25/00Z. This low now has increasing cloud amounts and organization associated with it.



CHICHI JIMA
115 IWO JIMA
945
103
131
20°
130°
140°
150°
160°
10°
SAIPAN
232
GUAM
218
217
ENIWETOK
ATOL
250
YAP
ULITHI
203
KOROR
408
WOLEAI ATOL
317
TRUK
334
PONAPE
348
KUSAIE
356
450
412
337
UMATAHACHI

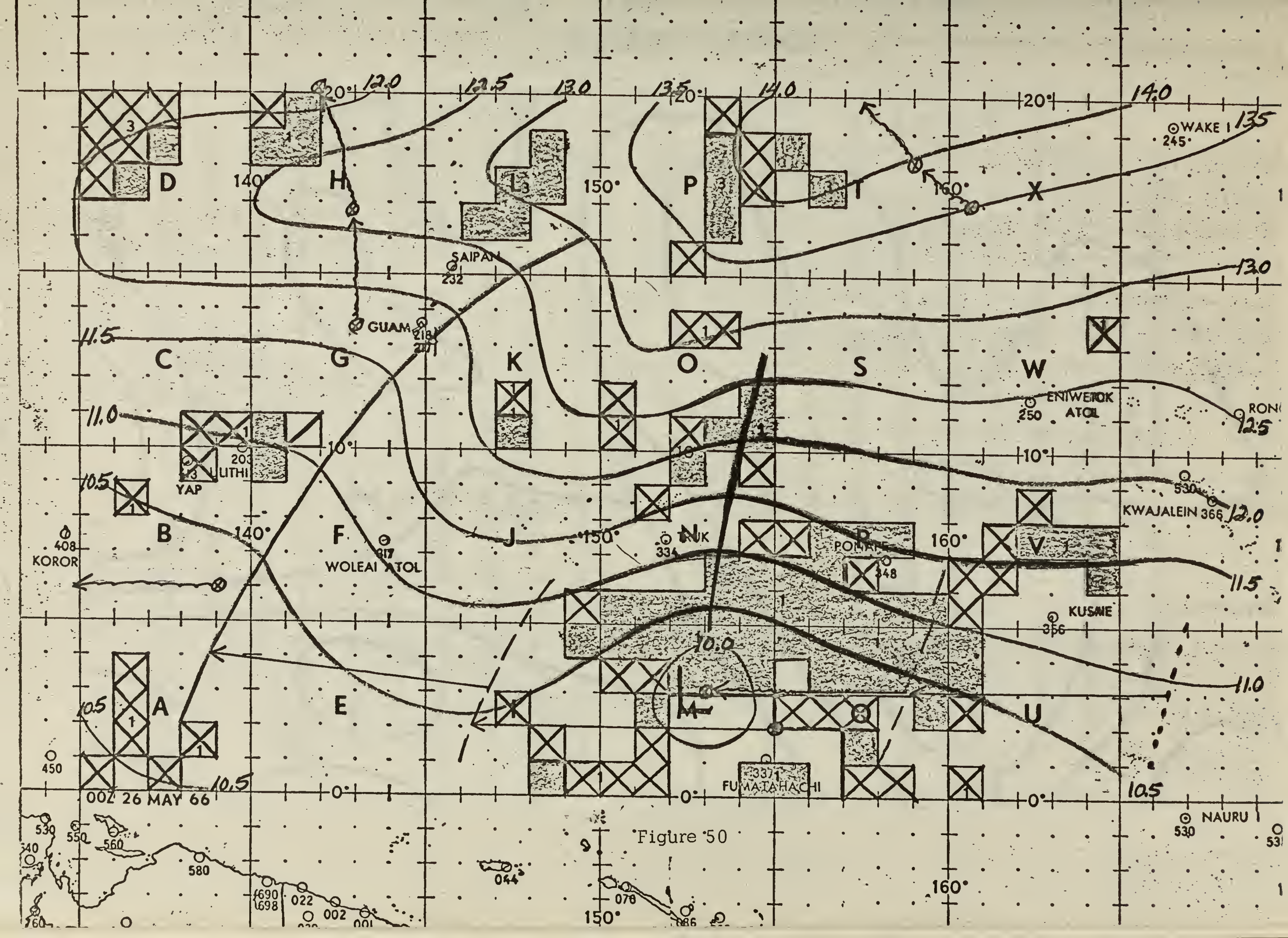
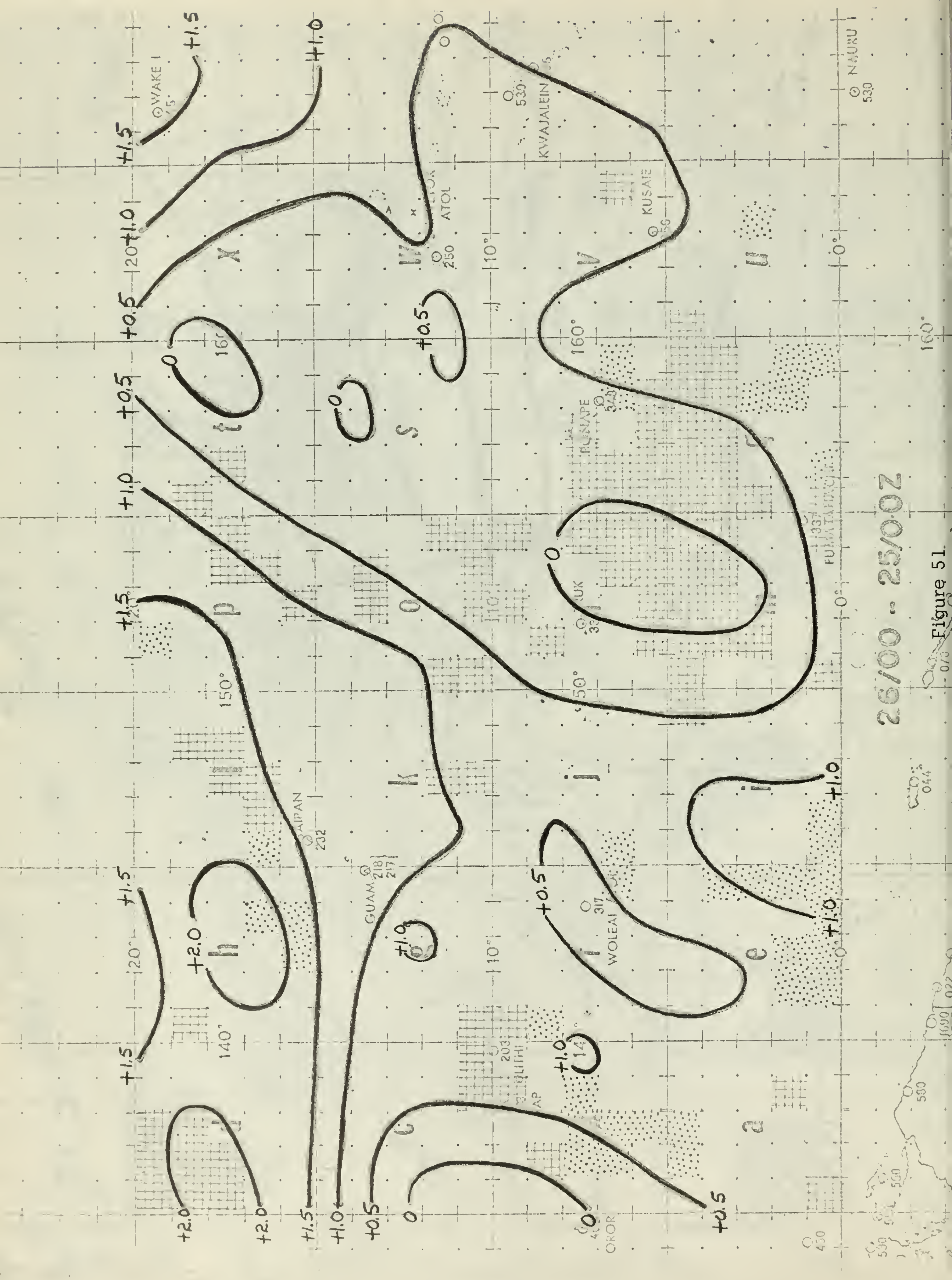

WAKE I
SAIPAN
GUAM
YAP
ULITHI
KOROR
WOLEAI ATOL
TRUK
PONAPE
ENIWETOK ATOL
KWAJALEIN
KUSAIE
NAURU
FUMATAHACHI
00Z 26 MAY 66

Figure 50



26/00 - 25/00Z
WAKE I
KWAJALEIN
KUSAIE
NAURU
PONAPE
WOLEAI
GUAM
SAIPAN
OROR
ATOL
+2.0
+1.5
+1.0
+0.5
0

Figure 51

Forecast of Clouds and Rainfall at Woleai for the Period
(26/00Z to 27/00Z)

The western edge of an extensive cloud mass is located 330 nm east southeast of Woleai. This large cloud mass is the expanded form of the cloud mass that was in blocks q, r and v at 25/00Z. Thus the cloud mass has moved with an apparent velocity of at least six degrees of latitude per day toward the west northwest. This movement places the cloud mass over Woleai a few hours prior to 27/00Z.

VERIFICATION

Fair to good. 0.32 inches of the total 0.38 inches of precipitation that fell during the period occurred late in the period.

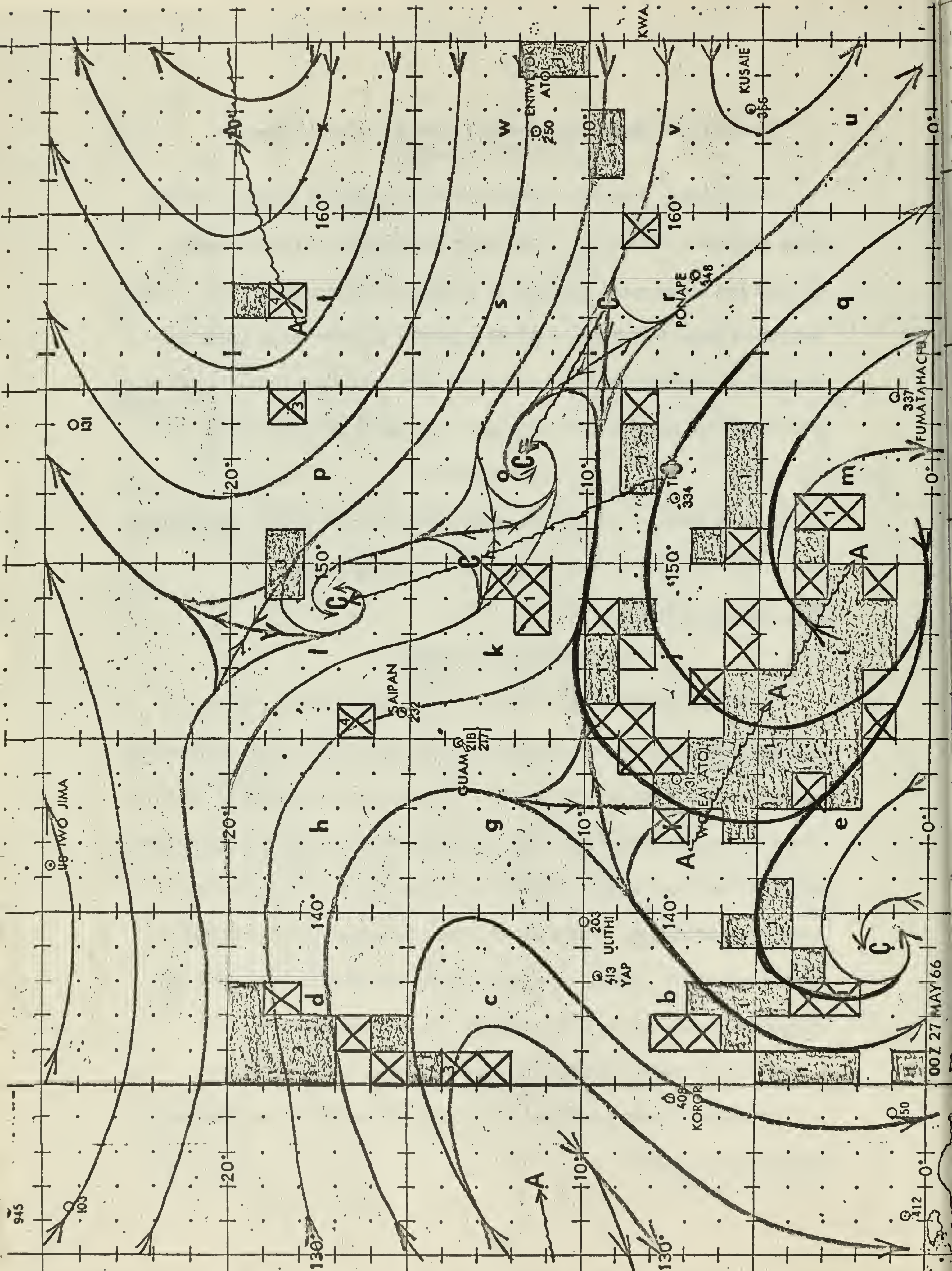
<u>00Z 27 MAY 1966</u> (figure 52, 53, 54)

UPPER AIR AND SURFACE

At 26/00Z a low at 3N 153E and its associated cloud mass were located under the eastern divergent asymptote of a tropical anticyclonic vortex at 4.5N 146.5E. At 27/00Z the same low is located at 4N 147E under the western divergent asymptote of the same tropical anticyclone which is now located at 2.5N 150.5E. The cloud mass associated with the low changed very little in size and shape in the interval mentioned above. This, in effect, shows the preferred location of a cloud mass with respect to upper and lower level systems.

24-HOUR ISALLOBARIC/ISALLONEPH FOR 27/00Z - 26/00Z

The cloud cover increases and decreases show a great deal of symmetry about 150E.



IWO JIMA
SAIPAN
232
GUAM
ULITHI
203
YAP
413
KOROR
408
WOLEAI ATOL
PONAPE
348
KUSAIE
356
ENIWETOK ATOL
250
334
337
131
103
412
50
00Z 27 MAY 66

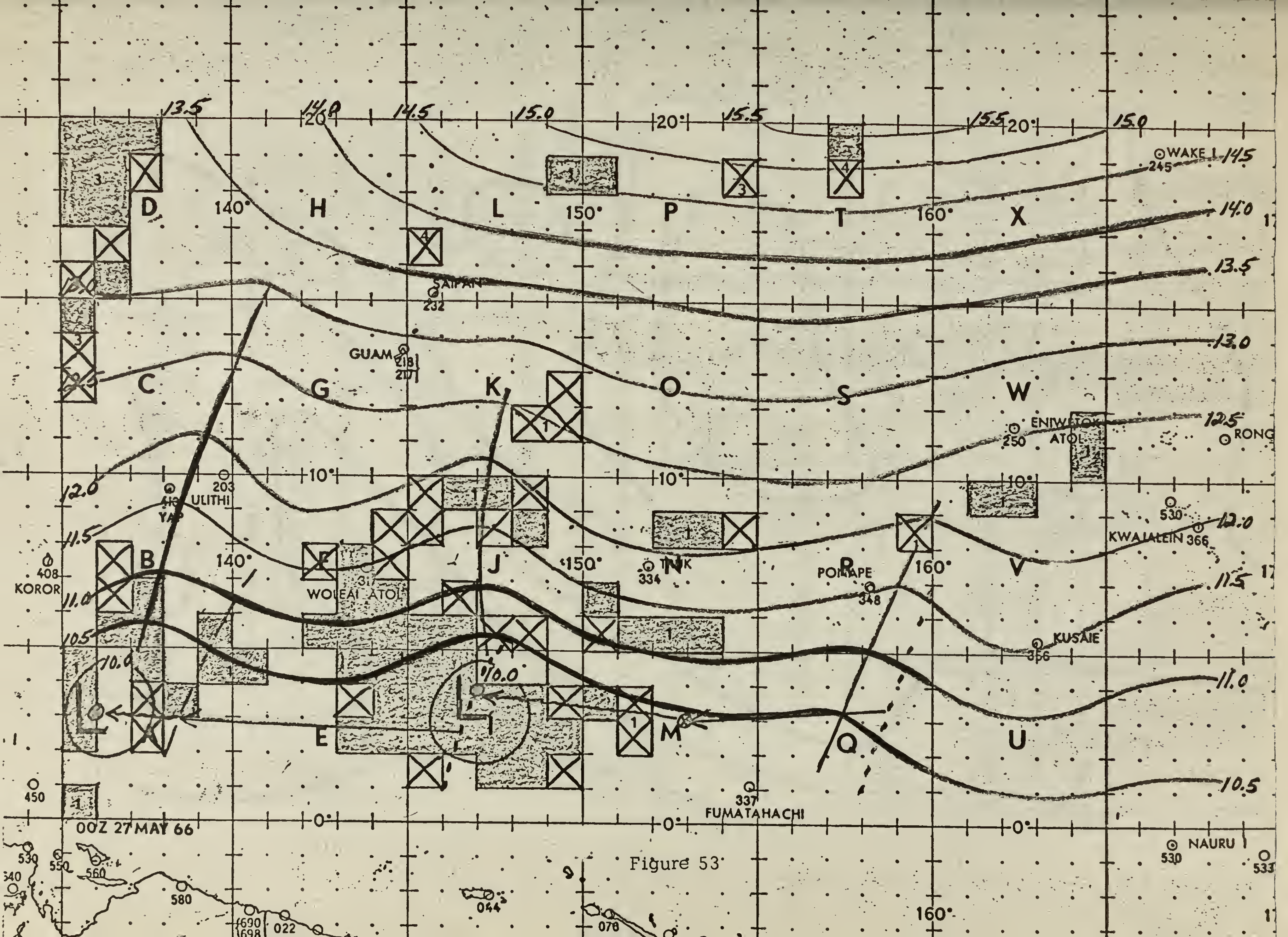

00Z 27 MAY 66
WAKE I.
SAIPAN
GUAM
ULITHI
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
KWAJALEIN
NAURU
FUMATAHACHI
13.5
14.0
14.5
15.0
15.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0

Figure 53

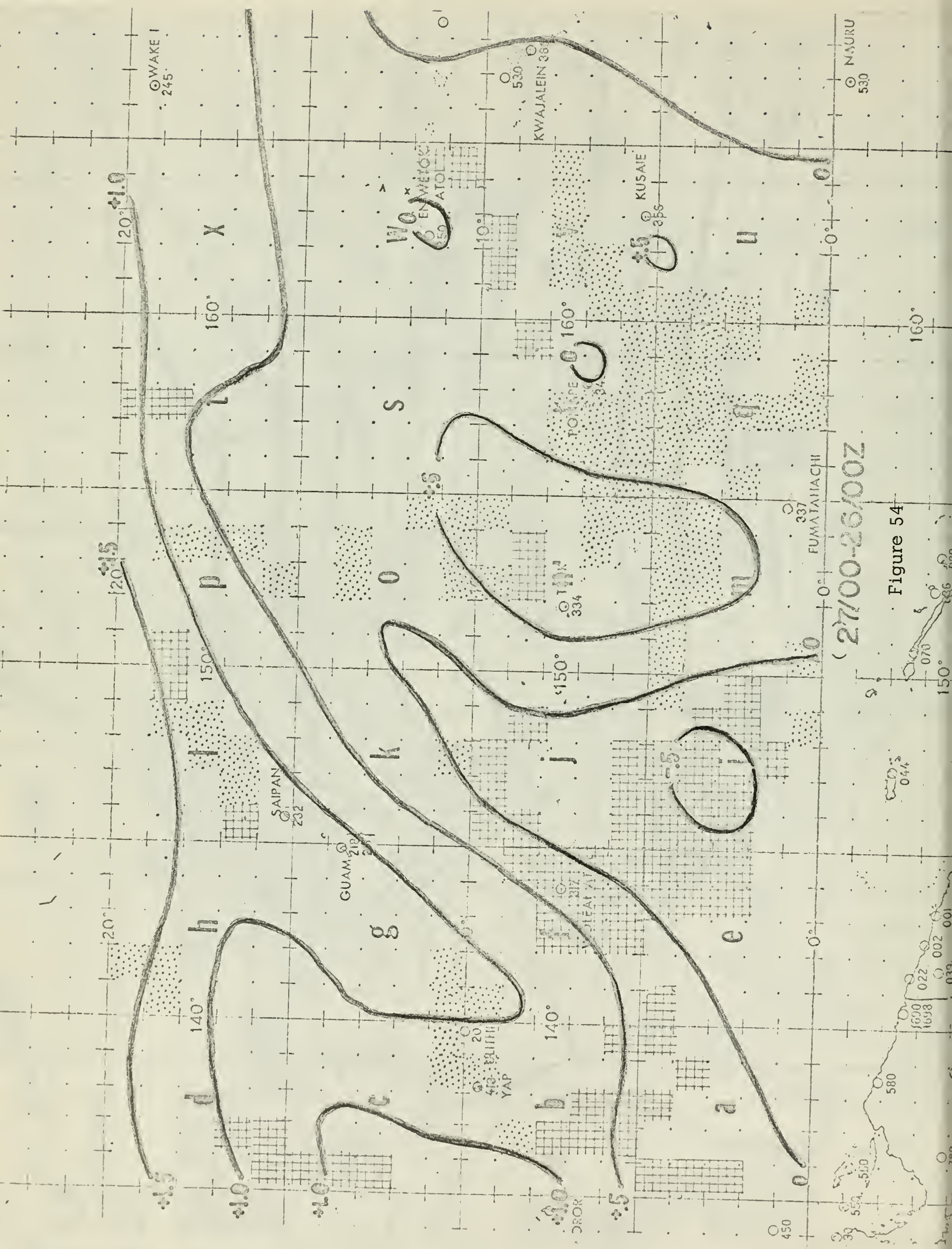

WAKE I
245
KWAJALEIN
NAURU
530
KUSAIE
PONAPE
FUMATAHACHI
337
SAIPAN
232
GUAM
YAP
27/00-26/00Z

Figure 54

Forecast of Clouds and Rainfall at Yap for the Period
27/00Z to 28/00Z

An extensive cloud mass is located 240 nm east southeast of Yap. This cloud mass is moving west northwest at slightly over six degrees of latitude per day. Therefore, shower activity is predicted from 27/14Z until the end of the period.

VERIFICATION

Good to excellent. 0.76 inches out of the total of 0.77 inches of rainfall occurred from 27/13Z to near the end of the period.

00Z 28 MAY 1966 (figures 55, 56, 57)

UPPER AIR

The subtropical anticyclone located at 13.5N 140.5E is weakening. This is due to the combination of a trough approaching it from the northwest and the cyclonic vortices located 15.5N 150.5E and 9.0N 154E moving toward it from the southeast.

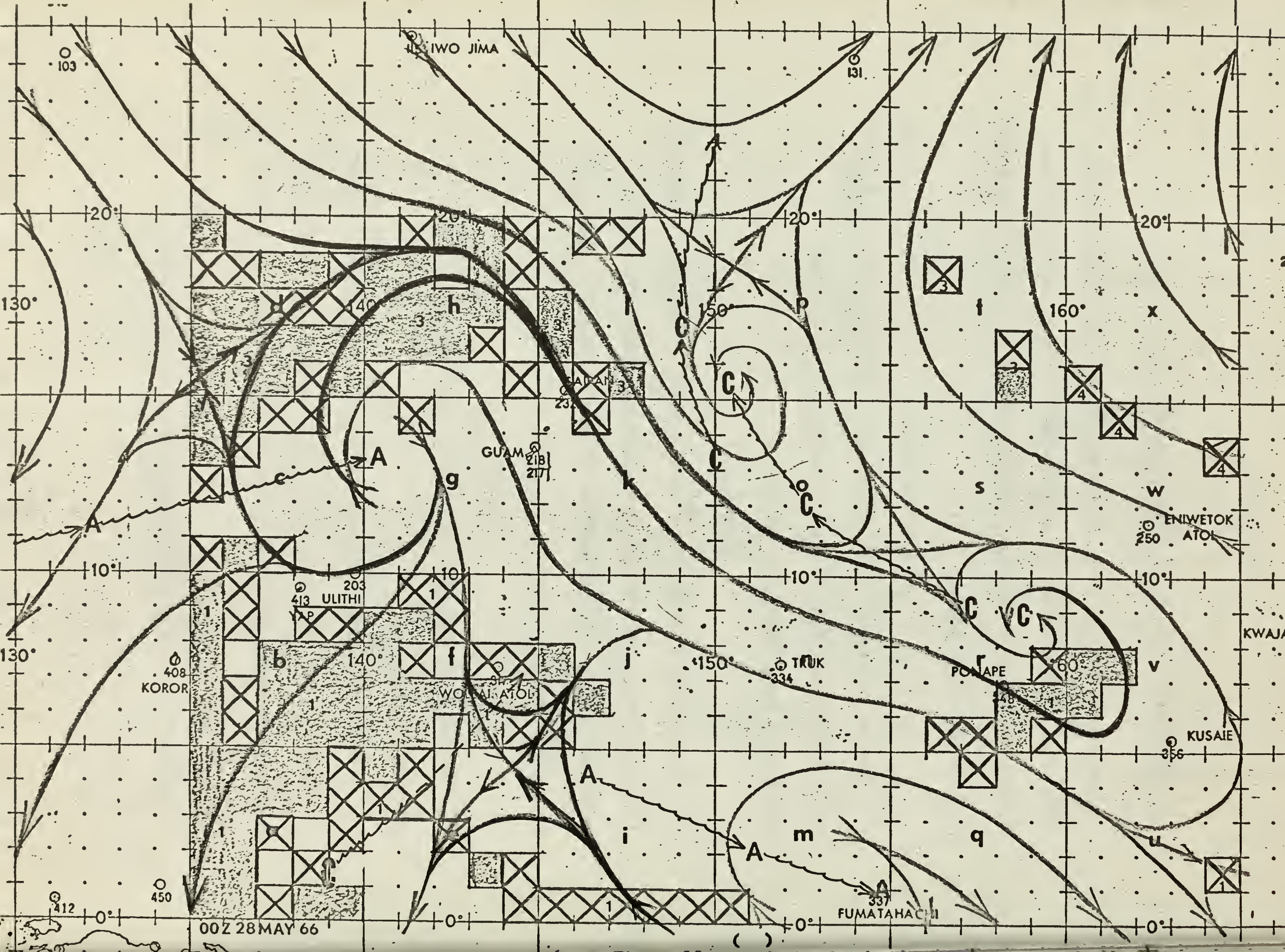
SURFACE

The low at 6N 140.5E has a slightly organized cloud mass associated with it.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 28/00Z - 27/00Z

West of 150E the correlation is quite good between the 24-hour isallobaric increase/decrease and the 24-hour decrease/increase of cloud cover.

Forecast of Clouds and Rainfall at Woleai for the Period
28/00Z to 29/00Z



IWO JIMA
GUAM
SAIPAN
ULITHI
YAP
KOROR
WOLEAI ATOL
TRUK
PONAPE
KUSAIE
ENIWETOK ATOL
FUMATAHACHI
00Z 28 MAY 66

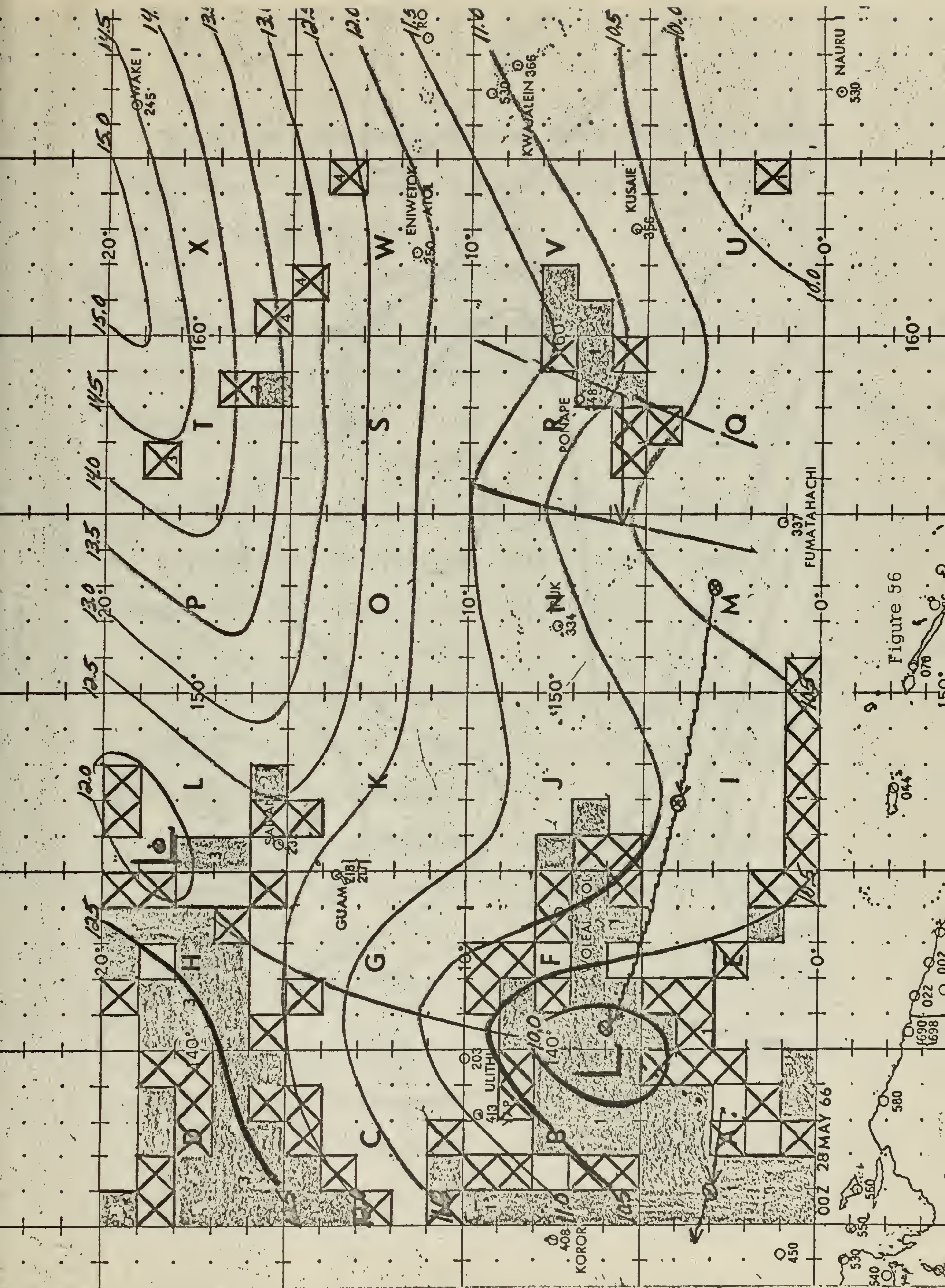
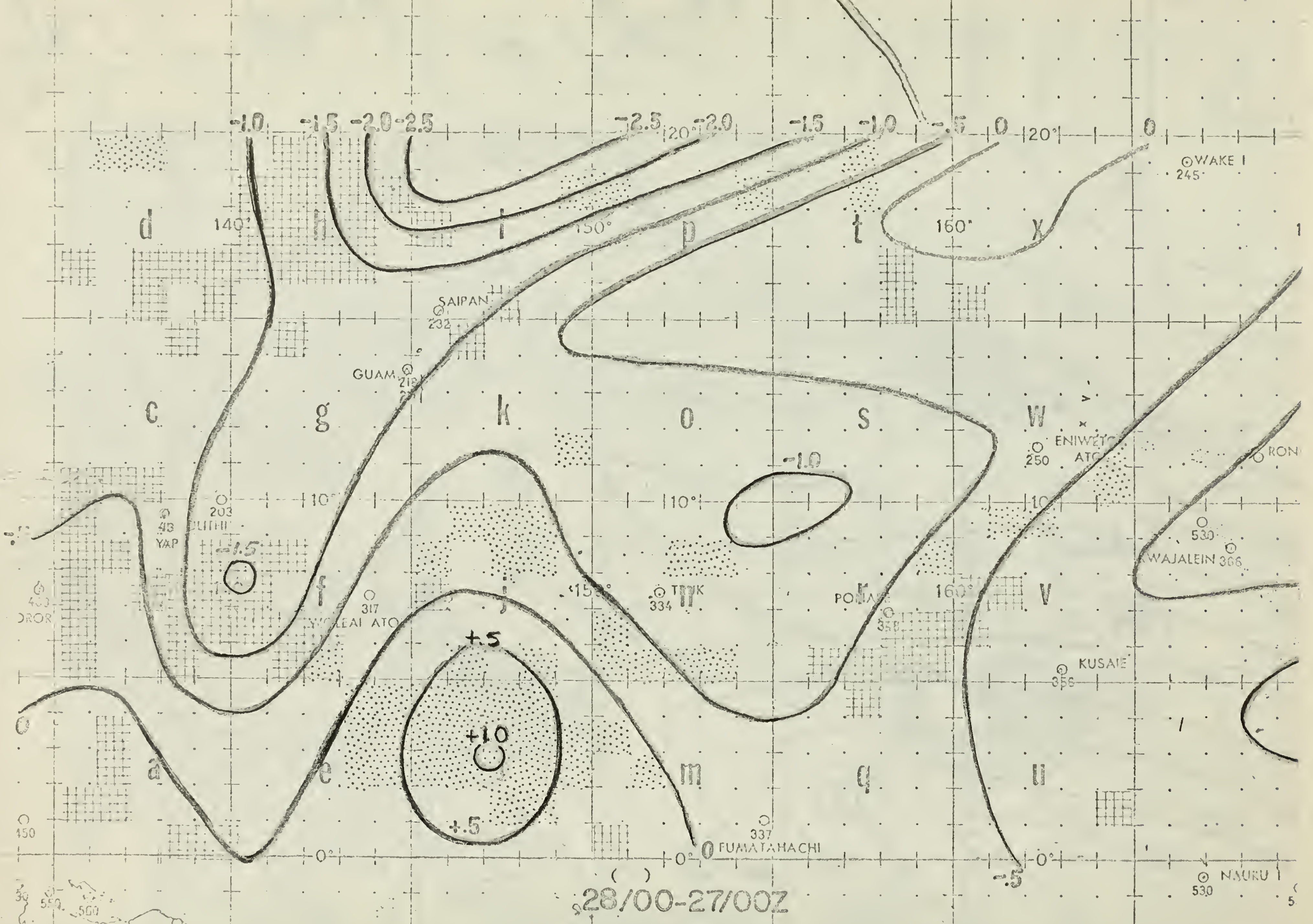

WAKE I
ENIWETOK ATOL
KWAJALEIN
KUSAIE
NAURU
PONAPE
FUMATAHACHI
TRUK
GUAM
SAIPAN
ULITHI
WOLEAI ATOL
KOROR
00Z 28 MAY 66

Figure 56


-1.0
-1.5
-2.0
-2.5
-2.5
-2.0
-1.5
-1.0
-.5
0
0
-1.0
-1.5
+.5
+1.0
+.5
-.5
20°
20°
140°
150°
160°
10°
10°
10°
160°
0°
0°
0°
160°
WAKE I
245
SAIPAN
232
GUAM
YAP
ULITHI
203
317
337
FUMATAHACHI
ENIWETOK ATOLL
250
KWAJALEIN 366
530
KUSAIE
356
NAURU
530
PONAPE
358
TRUK
334
ROR
450
580
044
28/00-27/00Z
Figure 57

The cloud mass over Woleai is moving west northwest at 15 knots. Since it measures 200 nm along the axis of movement shower activity is predicted from 28/00Z to about 28/13Z.

VERIFICATION

Good; 0.94 inches out of the total of 0.98 inches of rainfall that fell during the period occurred between 28/00Z and 28/13Z.

00Z 29 MAY 1966 (figures 58, 59, 60)

UPPER AIR

The general lack and weakness (i.e. mostly cloud code 5) of type 1 cloudiness east of 140E is apparently due to the unusual influence of the large cold cyclonic vortex at 15N 153.5E.

SURFACE

The low at 6N 140.5E at 28/00Z has opened up into a relatively minor trough in blocks a and b. The cloud mass associated with it has become completely disorganized.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 29/00Z - 28/00Z

The cloud increases in western and northern block j appear to be due to development in situ.

Forecast of Clouds and Rainfall at Woleai for the Period
29/00Z to 30/00Z

The leading edge of an extensive (420 nm east to west) cloud mass is located 130 nm east southeast of the station. It is moving at least 25 kt to the west northwest. The westernmost 180 nm of the cloud mass is composed of cloud code 5 while the remainder is mostly made

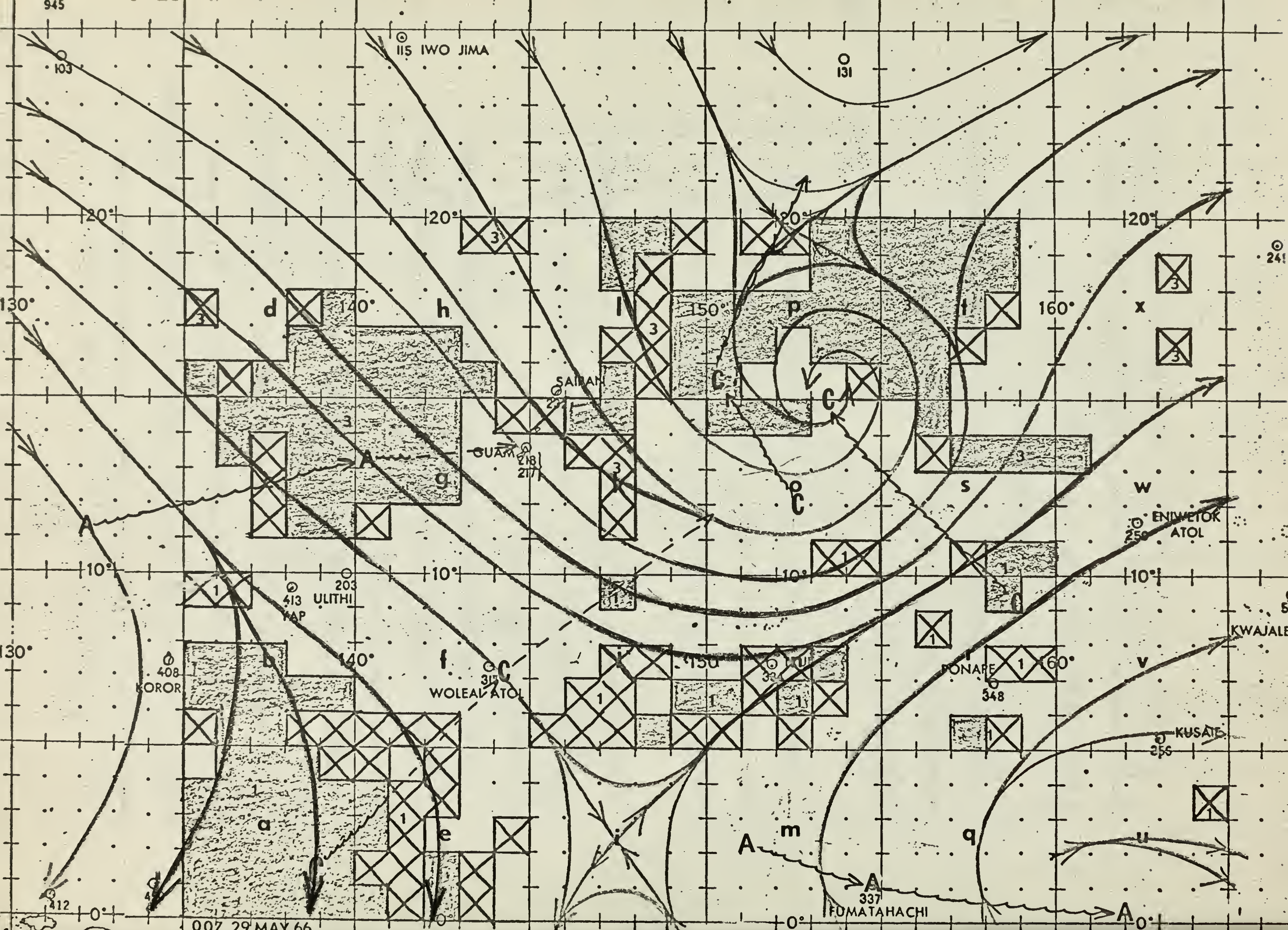
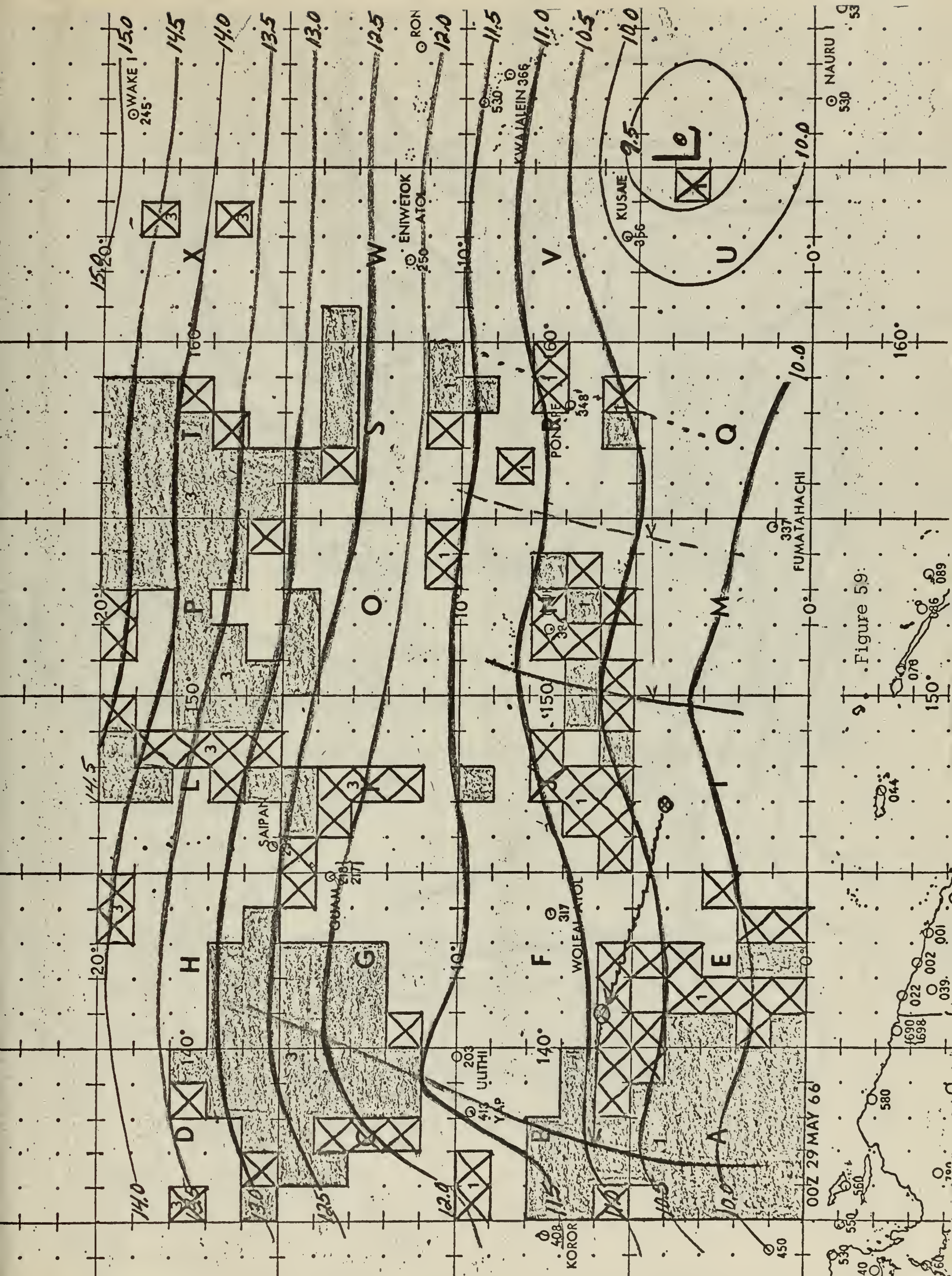
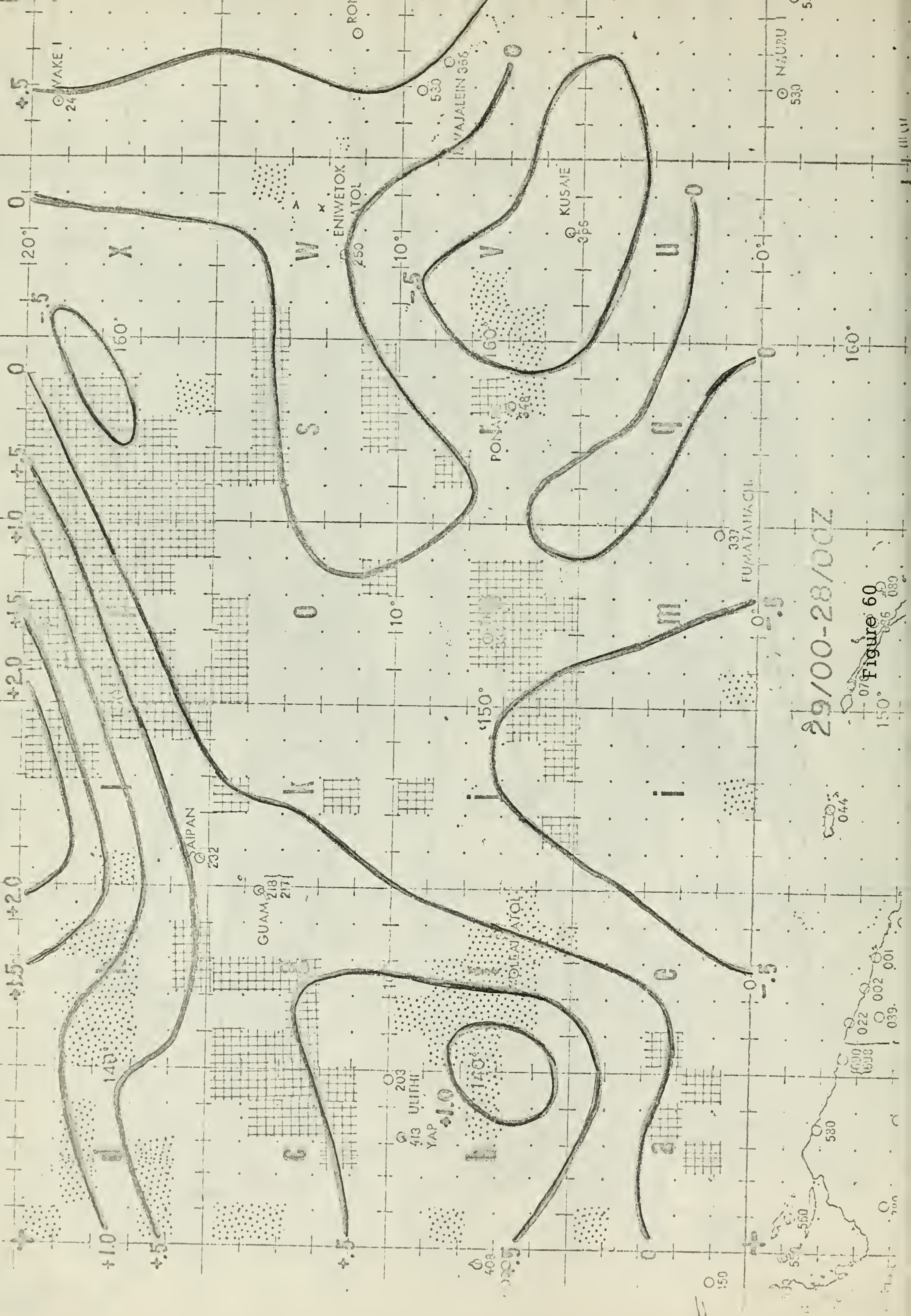

945
115 IWO JIMA
131
103
SAIPAN
GUAM
218
217
ULITHI
203
413
YAP
408
KOROR
WOLEAI ATOL
PONAPE
348
ENIWETOK
ATOL
KWAJALE
KUSAIE
256
337
FUMATAHACHI
412
00Z 29 MAY 66
130°
140°
150°
160°
20°
10°
0°

Figure 58



00Z 29 MAY 66
WAKE I
ENIWETOK ATOL
KWAJALEIN
KUSAIE
NAURU
PONAPE
FUMATAHACHI
WOLEAI ATOL
GUAM
SAIPAN
ULITHI
YAP
KOROR

Figure 5.9



WAKE I
ENIWETOK
ATOL
KUSAIE
NAURU
SAIPAN
GUAM
ULITHI
YAP
29/00-28/00Z

Figure 60

up of cloud code 6. Therefore, light shower activity is predicted from 29/05Z to 29/12Z and somewhat heavier shower activity from 29/12Z to the end of the period.

VERIFICATION

Good to excellent; 0.03 inches out of the total 0.22 inches for the period fell between 29/06Z and 29/12Z while 0.18 inches fell during the remainder of the period.

00Z 30 MAY 1966 (figures 61, 62, 63)

The discussions in this appendix conclude with this date, although charts were prepared for consistency up through 01/00Z June 1966.

UPPER AIR

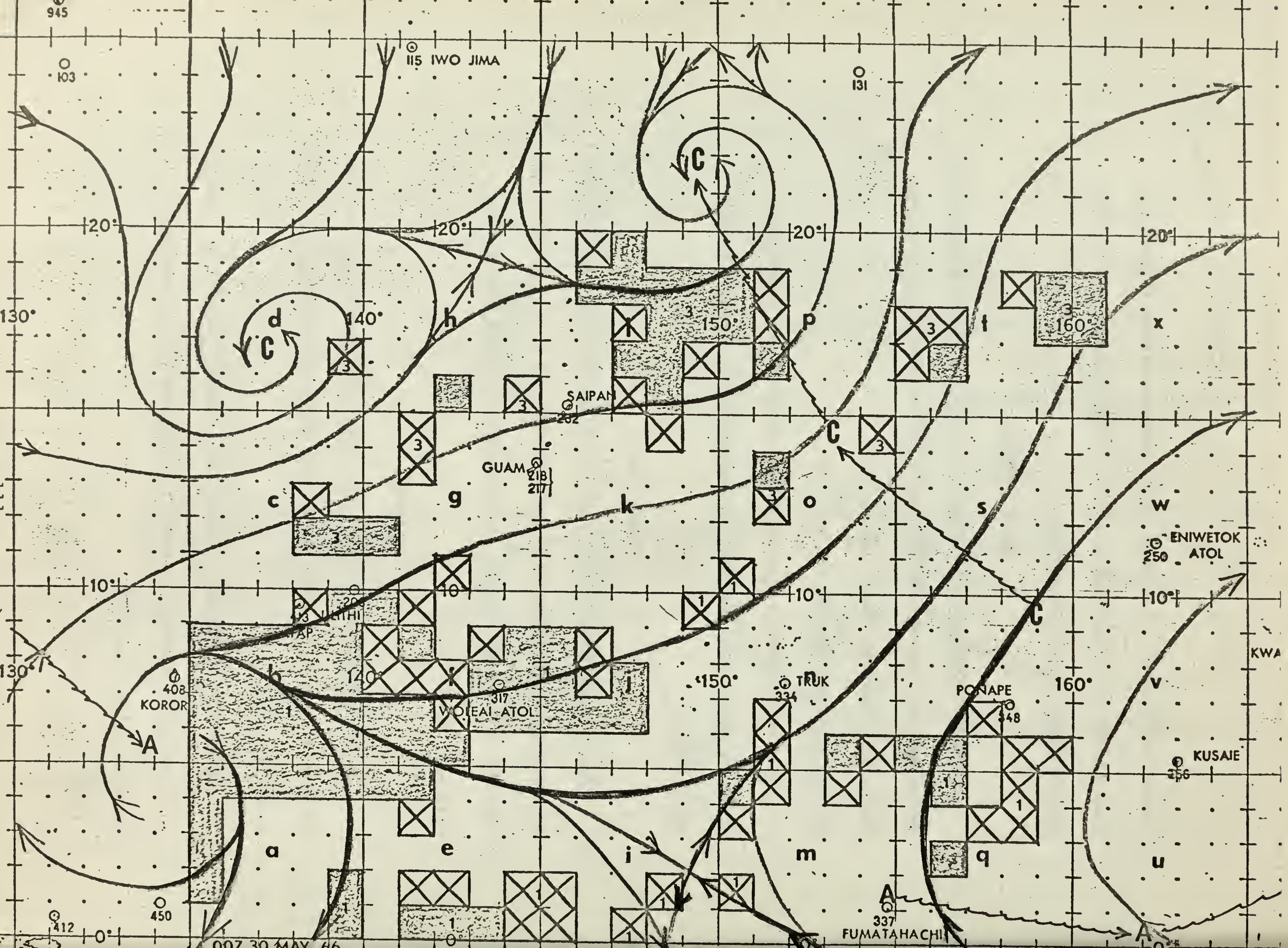
The tropical anticyclonic vortex at 5.5N 134E has been moving southeastward and apparently was generated as an eddy breaking off from the subtropical high far to the northwest of the area several days ago (figure 9).

SURFACE

The perturbation in blocks i and n at 29/00Z has developed into the low at 3N 143.5E. The cloud mass associated with it has become more organized.

24-HOUR ISALLOBARIC/ISALLONEPH CHART FOR 30/00Z - 29/00Z

The cloud increases in block i appear due to cross-equator movement of a cloud mass.


945
103
115 IWO JIMA
131
20°
130°
140°
150°
160°
10°
0°
SAIPAN
262
GUAM
218
217
ENIWETOK ATOL
250
KOROR
408
317
WOLEAI ATOL
TRUK
334
PONAPE
348
KUSAIE
356
337
FUMATAHACHI
450
412
KWA
007 30 MAY 46

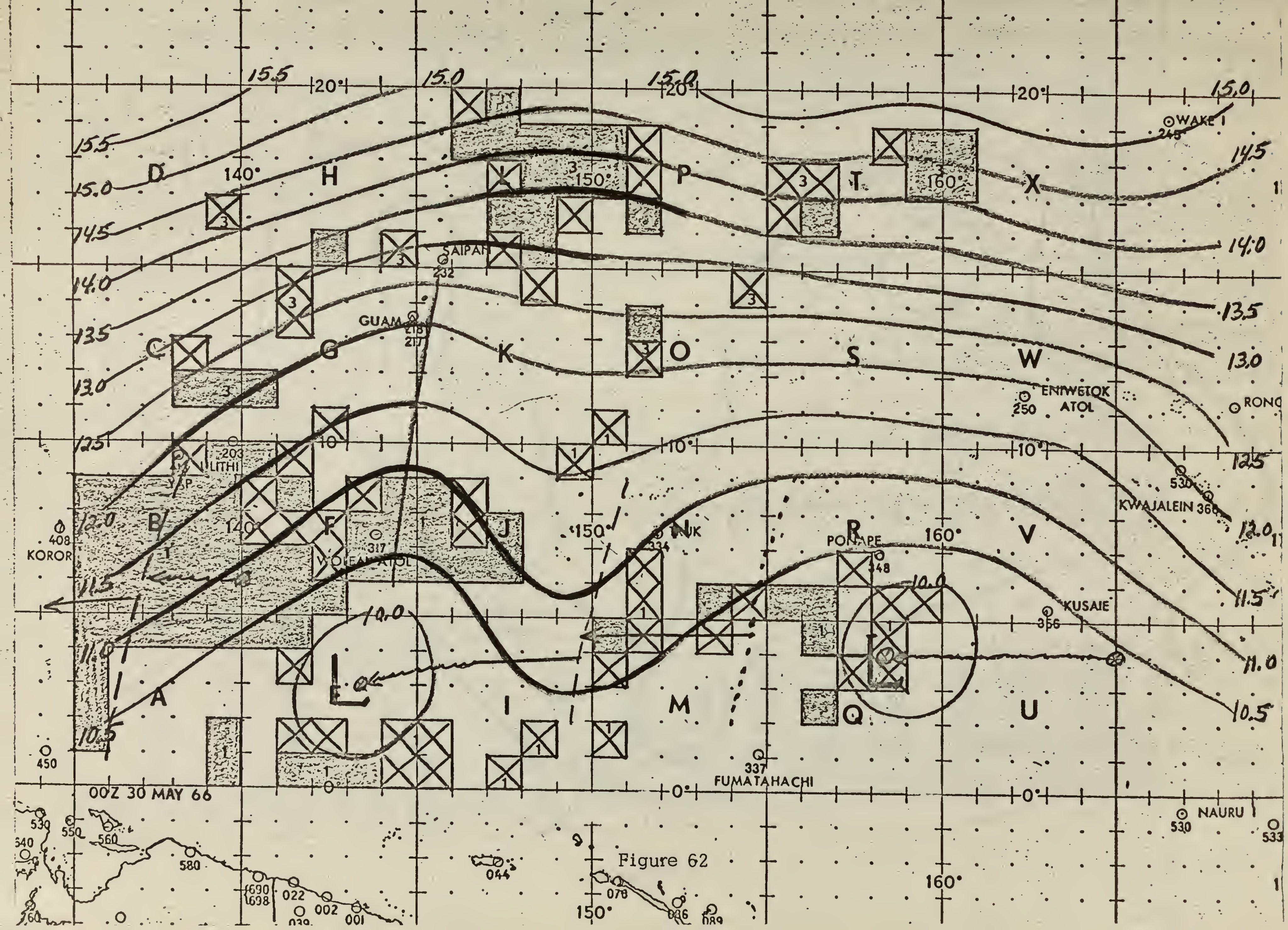
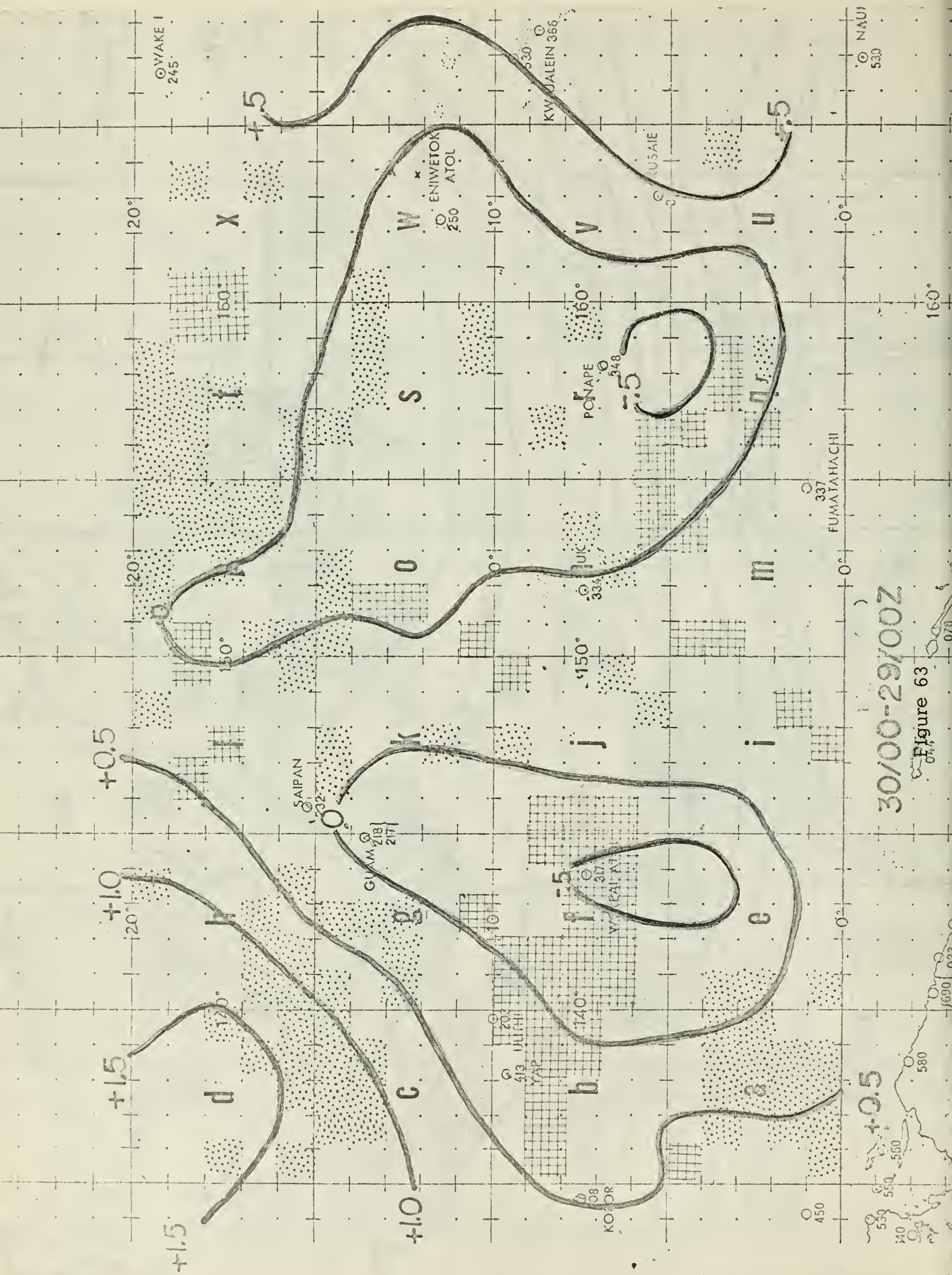

00Z 30 MAY 66
WAKE I
SAIPAN
GUAM
ENIWETOK ATOL
KWAJALEIN
KUSAIE
PONAPE
FUMATAHACHI
KOROR
YAP
ULITHI
WOLEAI ATOL
TRUK
NAURU
RONG

Figure 62



30/00-29/00Z
WAKE I
245
KWAJALEIN 366
ENIWETOK ATOL
250
KUSAIE
PONAPE
348
TRUK
334
FUMATAHACHI
337
SAIPAN
GUAM
218
217
ULITHI
YAP
413
KOROR
+1.5
+1.0
+0.5
+.5
-.5

Figure 63

APPENDIX II. Vertical Time Section

Guam

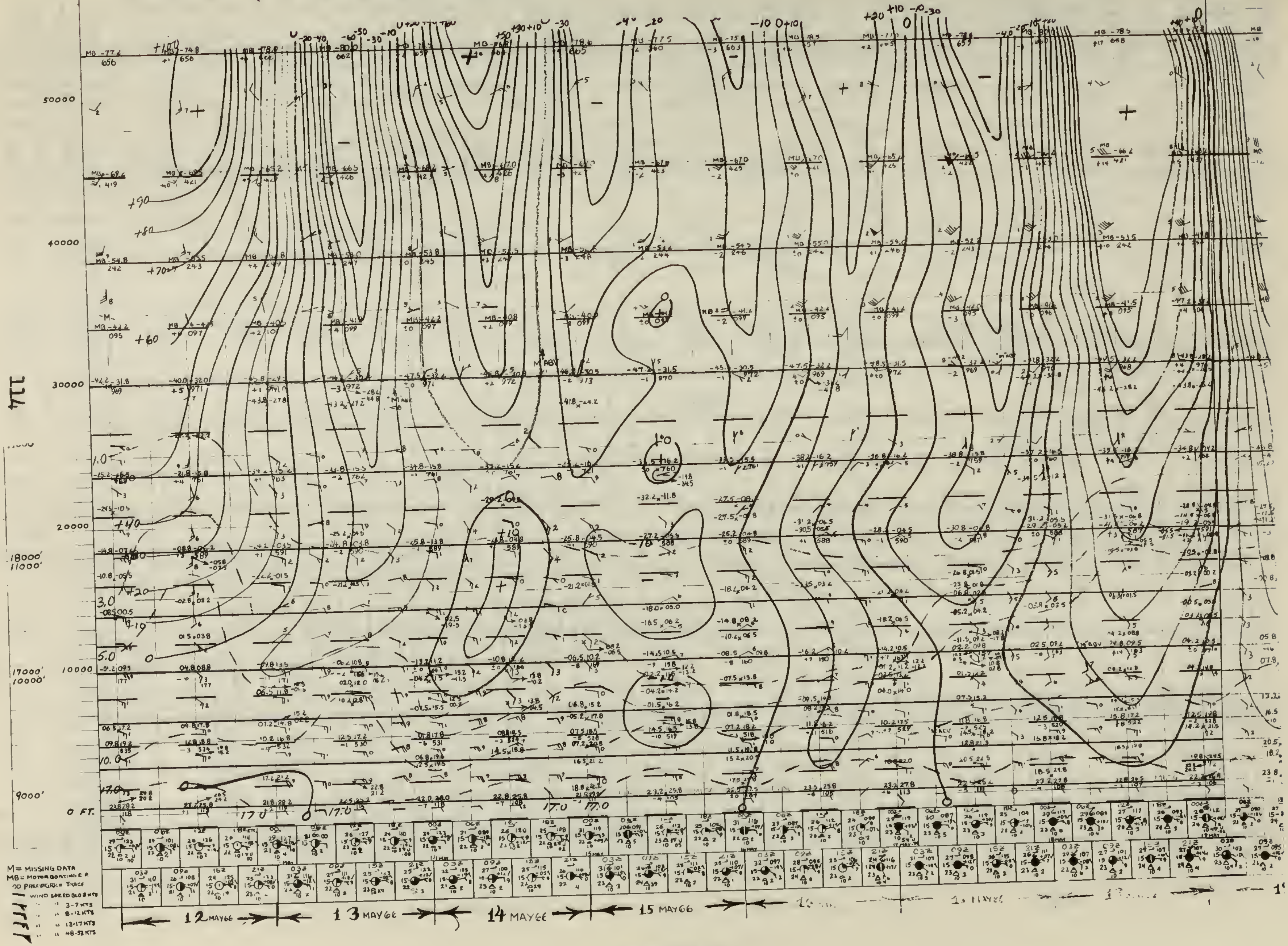
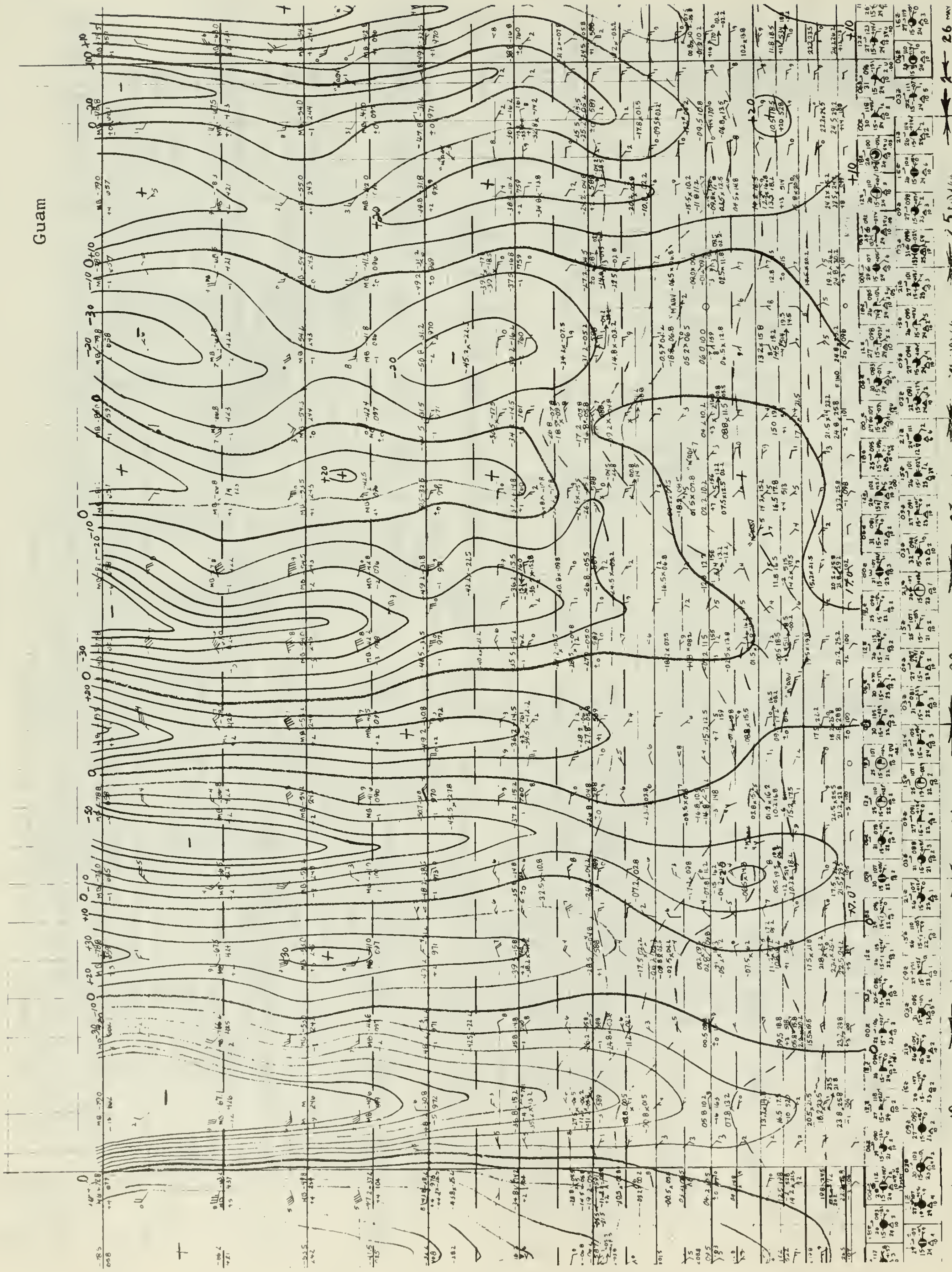


Figure 64

Guam



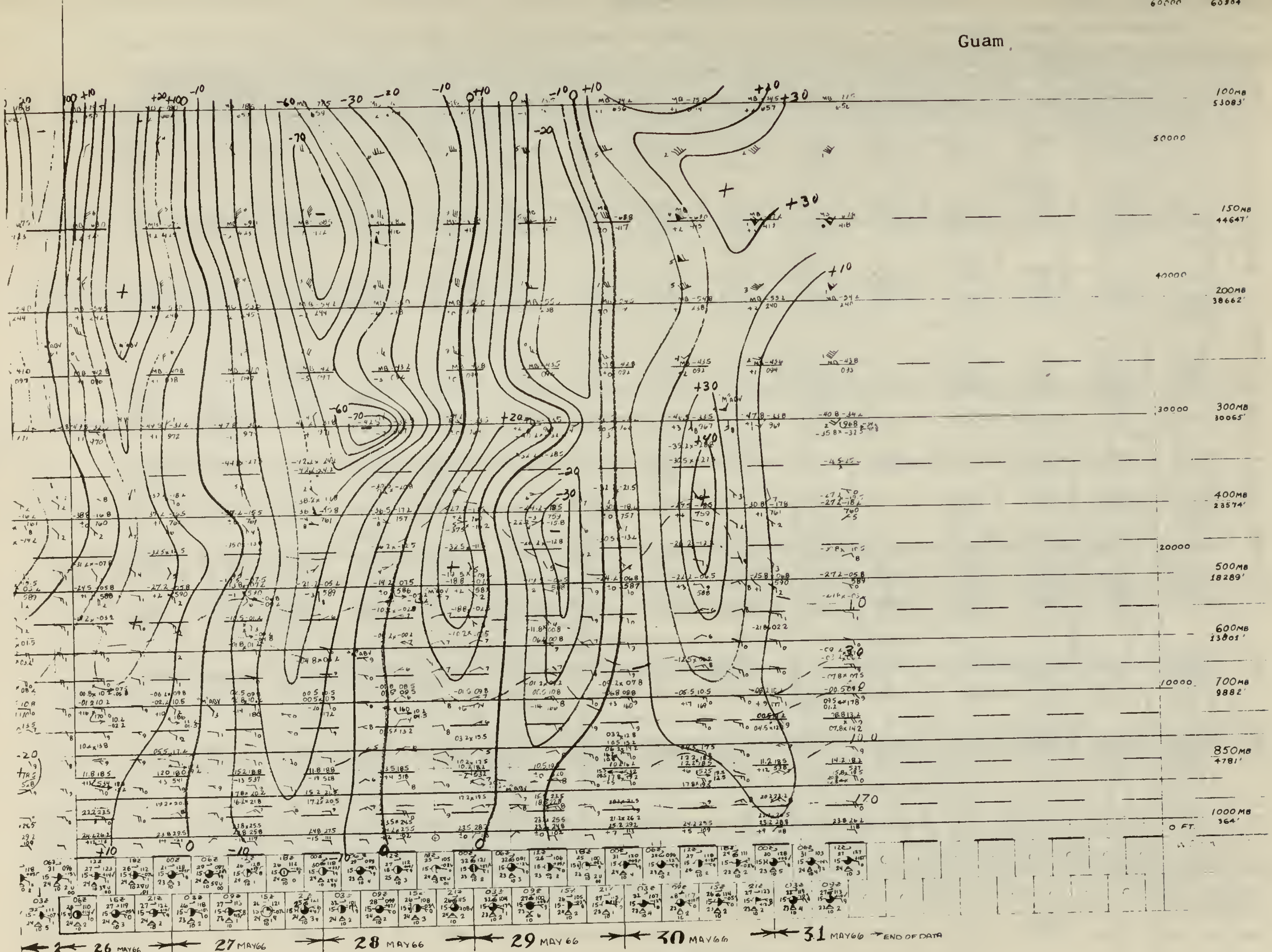

Guam
100MB
53083'
50000
150MB
44647'
40000
200MB
38662'
300MB
30065'
30000
400MB
23574'
20000
500MB
18289'
600MB
13801'
700MB
9882'
10000
850MB
4781'
1000MB
364'
0 FT.
26 MAY66
27 MAY66
28 MAY66
29 MAY 66
30 MAY66
31 MAY66
END OF DATA

Figure 66

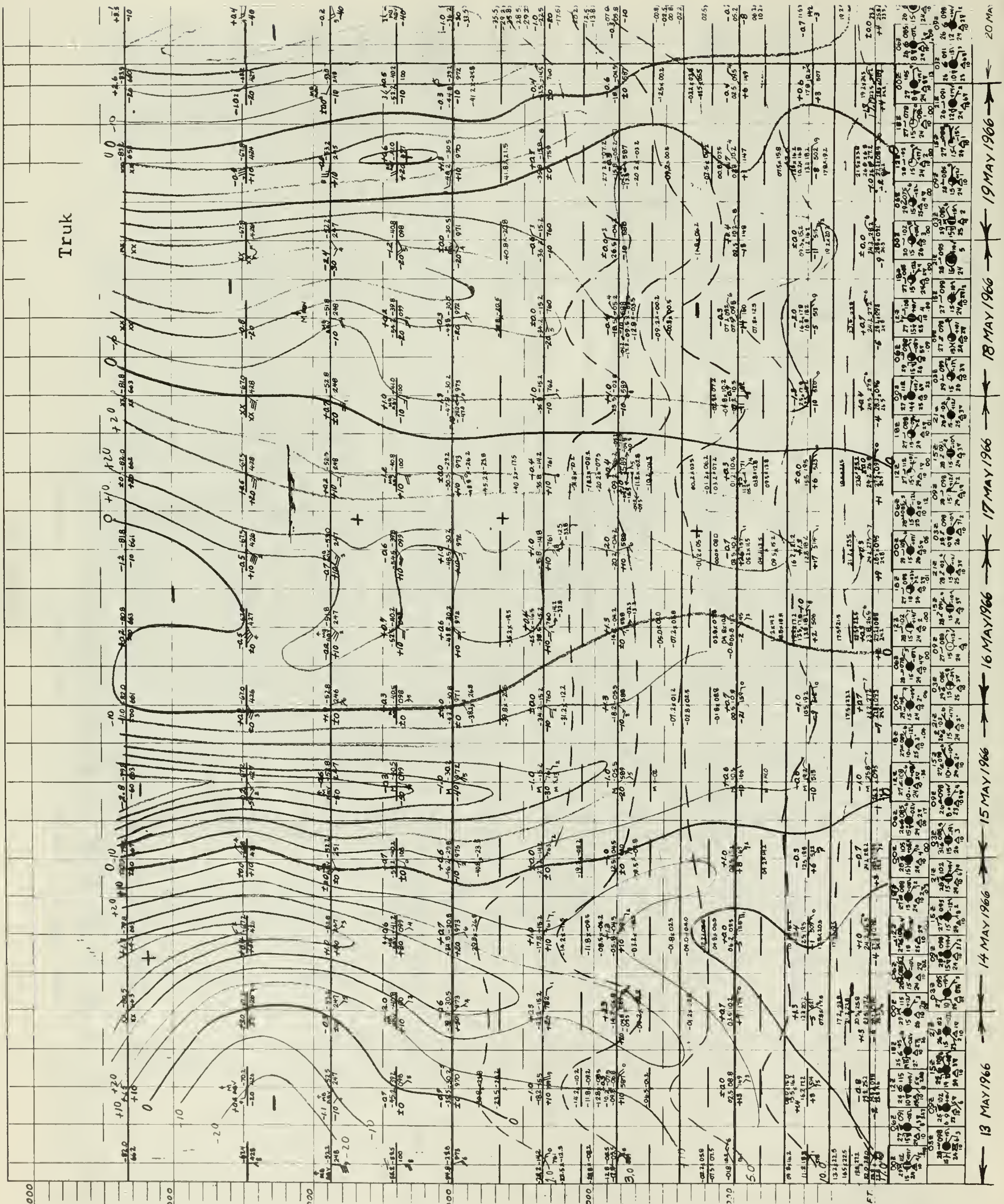

Truk
60000
50000
30000
20000
0 FT.
13 MAY 1966
14 MAY 1966
15 MAY 1966
16 MAY 1966
17 MAY 1966
18 MAY 1966
19 MAY 1966
20 MAY

Figure 67

Truk

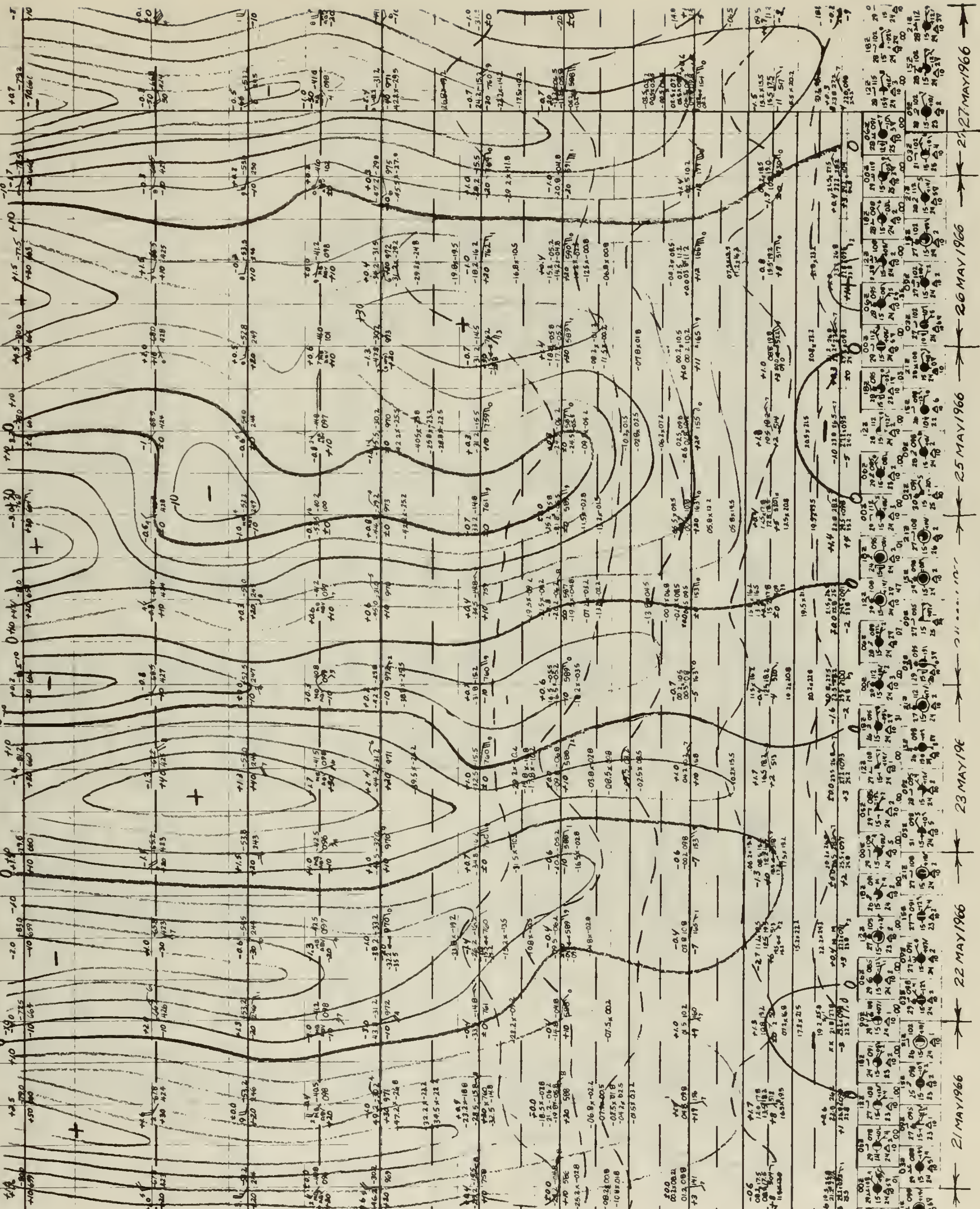


Figure 68

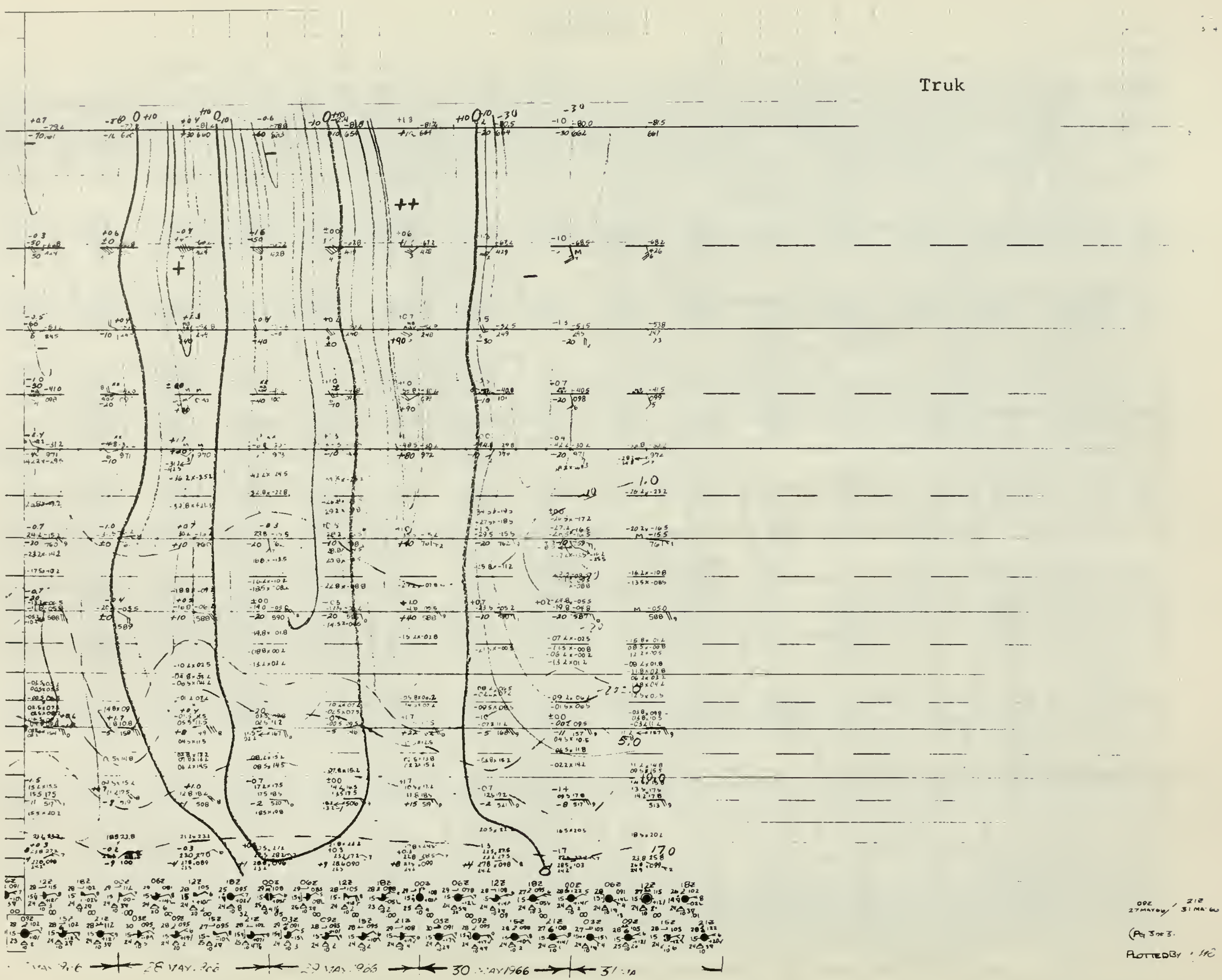


Figure 69

APPENDIX III. Rainfall Statistics

Rinfall inform[illegible] [illegible]od in this study is listed as follows:

WBAS Truk, Caroline Islands

RW-	130502 to 0330Z	
RW-	0420 to 0440	
RW--	0440 to 0450	
RW-	0450 to 0500	
RW-	0500 to 0519	0.32
RW-	0808 to 0814	
RW	0814 to 0817	
RW-	0817 to 0831	
RW	0831 to 0846	
RW-	0846 to 0918	
RW-	1025 to 1056	
RW-	1110 to 1120	
RW-	1145 to 1230	0.20
RW-	1424 to 1446	
RW-	1508 to 1520	
RW-	1606 to 1617	
T	1641 to 1731	
RW-	1650 to 1651	
RW-	1651 to 1657	
RW-	1657 to 1740	0.36
		0.88 in
RW--	140055 to 0115Z	
T	0206 to 0222	
RW-	0209 to 0215	
RW-	0213 to 0238	
RW--	0250 to 0301	
RW--	0355 to 0415	0.02
RW--	0854 to 0907	0.03
		0.05 in
RW-	150330 to 0338Z	
RW-	0421 to 0430	
RW	0430 to 0520	
RW-	0520 to 0550	0.17
RW--	0550 to 0615	
RW-	0615 to 0626	
RW	0626 to 0648	
RW-	0648 to 0652	
RW-	0712 to 0730	
R-	0730 to 0950	
R	0950 to 1030	
R-	1030 to 1220	0.35
R--	1220 to 1415	
R-	1415 to 1812	0.04
R	1812 to 1818	
R-	1818 to 1840	0.06
		0.62 in
RW-	160110 to 01[illegible]	
RW-	1246 to 1255	
RW-	1545 to 1554	0.01
RW-	1817 to 1818	
RW	1818 to 1822	
RW-	1822 to 1825	
RW-	1908 to 1946	0.05
		0.06 in
RW-	170251 to 0254Z	
RW-	0254 to 0312	
RW--	0324 to 0350	0.12
RW-	0623 to 0638	
RW-	1614 to 1626	
RW	1626 to 1636	0.05
RW-	2222 to 2227	
RW-	2227 to 2239	
RW-	2239 to 2250	
RW--	2250 to 2255	
RW-	2338 to 2359	0.22
		0.39 in
RW-	180330 to 0348Z	
RW--	0348 to 0408	
RW-	0408 to 0415	
RW--	0415 to 0430	
RW-	0508 to 0520	0.09
RW--	0610 to 0633	
RW-	1155 to 1203	
RW-	1304 to 1316	0.00
		0.09 in
RW-	190206 to 0220Z	
RW	1818 to 1822	
RW-	1822 to 1830	
RW-	1915 to 1923	
RW-	2036 to 2038	
RW	2038 to 2052	
RW-	2052 to 2103	
RW-	2132 to 2150	
RW--	2340 to 2343	
RW	2348 to 2359	0.13
		0.13 in
RW+	200000 to 0028Z	
RW-	0028 to 0230	
RW-	0230 to 0411	
RW-	0516 to 0531	
RW	0531 to 0542	1.08
RW--	0542 to 0552	
RW	0552 to 0558	
RW-	0558 to 0631	
RW	0706 to 0724	
RW	0724 to 0742	
RW-	0742 to 0750	
RW--	0948 to 1021	0.22
RW-	2026 to 2033	
RW--	2044 to 2048	0.01
		1.31 in
	210000 to 2359Z	none
	220000 to 2359Z	none
RW-	231210 to 1252Z	
RW--	1252 to 1320	0.07
RW-	1430 to 1448	
RW--	1448 to 1514	
RW	1514 to 1524	
RW-	1524 to 1550	
RW--	1550 to 1650	0.31
		0.38 in
RW-	240004 to 0025Z	
RW-	0238 to 0245	
RW-	1001 to 1024	
RW+	1024 to 1032	
RW-	1032 to 1046	0.47
RW-	1702 to 1712	0.01
		0.48 in
RW-	251445 to 1530Z	
RW--	1530 to 1710	
RW--	1850 to 1935	0.03
		0.05 in
RW	260105 to 0105Z	
RW--	0105 to 0110	
RW--	0124 to 0127	
RW+	0127 to 0135	
RW-	0135 to 0145	
RW--	0145 to 0155	
RW--	0235 to 0240	
RW-	0411 to 0421	0.35
RW-	1904 to 1920	0.00
		0.35 in
RW--	270431 to 0433Z	
RW--	0530 to 0540	
RW-	1155 to 1203	
RW--	1920 to 1930	
RW--	2103 to 2108	0.00
		0.00 in
RW-	281334 to 1350Z	
RW-	1645 to 1650	
RW-	1720 to 1728	
RW-	1731 to 1734	
RW+	1734 to 1745	0.32
RW	1745 to 1800	
RW-	1800 to 1818	
RW--	1818 to 1835	
RW-	1906 to 1915	
T	1923 to 1945	
RW-	1929 to 1950	
RW--	2121 to 2140	0.05
		0.38 in
RW-	290240 to 0250Z	
RW--	0530 to 0534	
RW-	2345 to 2359	0.00
		0.00 in

WBAS Eniwetok, M.I.

	130000 to 2359Z	none
RW-	141520 to 1545Z	
RW-	1650 to 1718	0.05
		0.05 in
RW-	150930 to 0950Z	0.02 in
RW--	161243 to 1250Z	
RW--	1332 to 1340	0.00
		0.00 in
RW-	170016 to 0025Z	
RW-	0310 to 0315	0.08
RW-	0521 to 0540	
RW-	1305 to 1315	
RW-	1340 to 1355	
RW-	1812 to 1905	
RW--	2320 to 2335	0.25
		0.33 in
	180000 to 2359Z	none
	190000 to 2359Z	none
	200000 to 2359Z	none
RW-	210918 to 0930Z	0.08
RW--	1845 to 1855	0.00
		0.08 in
RW--	221345 to 1408Z	0.00 in
RW-	231702 to 1733Z	0.04 in
	240000 to 2359Z	none
	250000 to 2359Z	none
	260000 to 2359Z	none
RW-	270408 to 0416Z	
RW-	0425 to 0445	
RW-	0550 to 0610	0.04
		0.04 in
	280000 to 2359Z	none
	290000 to 2359Z	none

[illegible], Yap, Caroline Islands

R-	130020 to 0045Z	
RW-	1016 to 1240	0.03
RW-	1625 to 1640	0.00
		0.03 in
	140000 to 2359Z	none
	150000 to 2359Z	none
RW--	160720 to 0735Z	
RW--	0744 to 0747	
RW--	1144 to 1209	0.02
		0.02 in
RW--	170315 to 0322Z	0.00 in
RW-	180252 to 0324Z	
RW+	0324 to 0329	
RW-	0329 to 0332	0.06
RW-	0708 to 0713	
RW-	0713 to 0725	
RW-	0835 to 0840	
RW-	0922 to 0934	0.18
RW-	1416 to 1655	
R-	1655 to 1940	
R-	2010 to 2046	
R-	2126 to 2240	
R--	2240 to 2312	0.92
		1.16 in
R--	190050 to 0120Z	
R--	0151 to 0200	
R-	0200 to 0204	
R--	0204 to 0252	
R-	0252 to 0315	
R--	0315 to 0325	0.02
RW-	1353 to 1357	
RW-	1424 to 1510	
R-	1510 to 1644	
RW-	1644 to 1710	
R-	1710 to 1803	
RW-	1935 to 2010	
R--	2305 to 2307	0.40
		0.42 in
R--	200710 to 0724Z	
R--	0856 to 0936	
RW-	1210 to 1230	
RW-	2125 to 2137	
RW-	2230 to 2241	0.01
		0.01 in
RW-	210008 to 0014Z	
R-	0014 to 0219	0.03
		0.03 in
-	220000 to 2359Z	none
RW-	231324 to 1345Z	
RW--	1345 to 1426	0.00
		0.00
	240000 to 2359Z	none
RW-	252212 to 2242	0.01
		0.01 in
RW-	260517 to 0530Z	
RW--	0530 to 0544	0.01
		0.01 in
RW-	270322 to 0335Z	
RW-	0603 to 0613	0.01
RW-	1300 to 1315	0.12
RW+	1332 to 1344	
RW-	1344 to 1352	
RW--	1436 to 1444	
RW-	1615 to 1619	
RW+	1619 to 1623	
RW-	1623 to 1630	0.18
T	1723 to 1740	
RW--	1726 to 1819	
RW+	1819 to 1834	
RW-	1834 to 2110	0.46
		0.77 in
RW-	282115 to [illegible]	
RW	[illegible]	
RW-	[illegible]	
R--	[illegible]	[illegible]
T	[illegible]	
RW-	[illegible]	
RW+	1502 to [illegible]	
T	[illegible]	
RW	[illegible]	[illegible]
RW-	[illegible]	[illegible]
		[illegible] in
	290000 to [illegible]	none

Woleai, W.C.I.

	130000 to 2359Z	none
	140000 to 1159Z	0.02
	1200 to 2359	0.13
		0.15 in
	150000 to 0559Z	0.02
	0600 to 1159	none
	1200 to 2359	[illegible]
		0.56 in
	160000 to 0559Z	none
	0600 to 1159	0.11
	1200 to 2359	1.22
		1.35 in
	170000 to 0559Z	0.15
	0600 to 1159	none
	1200 to 2359	none
		0.15 in
	180000 to 0559Z	none
	0600 to 1159	0.05
	1200 to 2359	0.67
		0.70 in
	190000 to 0559Z	0.05
	0600 to 1159	0.11
	1200 to 2359	0.02
		0.18 in
	200000 to 2359Z	none
	210000 to 2359Z	none
	220000 to 2359Z	none
	230000 to 1159Z	none
	1200 to 2359	0.20
		0.20 in
	240000 to 0559Z	0.65
	0600 to 1159	none
	1200 to 2359	0.04
		0.69 in
	250000 to 1159Z	none
	1200 to 2359	0.14
		0.14 in
	260000 to 0559Z	none
	0600 to 1159	0.06
	1200 to 2359	0.32
		0.38 in
	270000 to 0559Z	0.04
	0600 to 1159	0.04
	1200 to 2359	0.20
		0.28 in
	280000 to 0559Z	0.17
	0600 to 1159	0.75
	1200 to 2359	0.06
		0.98 in
	290000 to 0559Z	0.01
	0600 to 1159	0.03
	1200 to 2359	0.18
		0.22 in

[illegible]

RW-	[illegible]	
RW-	[illegible]	[illegible]
RW-	[illegible]	[illegible] in
RW-	[illegible]	
RW-	[illegible]	[illegible]
		[illegible] in
RW-	16[illegible]	
RW+	[illegible]	
RW-	[illegible]	
RW+	[illegible]	
RW-	[illegible]	[illegible]
		[illegible] in
	[illegible]	[illegible]
RW-	[illegible]	[illegible] in
RW--	[illegible]	
RW	2215 to [illegible]	[illegible]
		[illegible] in
	200000 to [illegible]	[illegible]
RW-	[illegible]	[illegible] in
	220000 to [illegible]	none
RW--	[illegible]	
RW	[illegible]	[illegible]
RW-	[illegible]	
RW+	[illegible]	
RW-	[illegible]	[illegible]
RW	[illegible]	
RW-	[illegible]	[illegible]
		[illegible] in
RW+	24[illegible]	[illegible] in
RW-	25[illegible]	
RW+	[illegible]	[illegible]
RW-	[illegible]	
RW--	[illegible]	
RW-	[illegible]	[illegible]
		[illegible] in
RW--	26[illegible]	
RW--	[illegible]	
RW--	[illegible]	[illegible]
		[illegible] in
RW-	27[illegible]	
RW--	1202 to [illegible]	
RW+	[illegible]	[illegible]
		[illegible] in
RW--	281[illegible]	
RW-	1527 to [illegible]	[illegible]
		[illegible] in
RW-	292705 to [illegible]	[illegible] in

Figure 70

SECTION V

RECOMMENDATIONS

The tropical ocean area is notorious for the lack of credible climatological cloud information. It is suggested that the coded cloud charts and isalloneph analyses are a suitable media for building an updated cloud climatology. For instance, one could even include average cloud cover by type as defined in this study.

Since a cloud photograph may very soon be transformed into a cloud code chart by machine methods, then such a field combined with cloud mass velocities could be used in a numerical prognostic cloud type and movement program. Additional cloud mass parameters (shrinking/expanding) developed by using the 250-mb analysis/ prognosis would also be useful.

The project discussed here could be advanced by a study of inter- and intradiurnal cloud development and movement. Pertinent ESSA 1, ESSA 2 and NIMBUS 2 photographs could be obtained for this purpose.

An accurate statistical study relating 24-hour cloud changes to pressure changes and divergence/convergence computations at 250 mb are certainly in order to quantitize the mostly qualitative approach taken by this author.

Since, at times, there was lack of clear cut relation between cloud masses and the surface and/or upper air flow patterns, mid-tropospheric charts, e.g., 500 mbs, need to be investigated.

SECTION VI

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Associate Professor Robert J. Renard for his guidance and assistance in this study. Appreciation is also expressed to the personnel of the U. S. Fleet Weather Central, Guam, and Harry Farnsworth at the U. S. Fleet Weather Central, Pearl Harbor, for their cooperation in furnishing data, and also to U. S. Navy Project FAMOS for ESSA 1 nephanalyses. LCDR Harry Bixby is thanked for assisting in processing the satellite data tapes received from Guam. Kenneth Roberts, Robert Campbell, Julia Winters and Robert Landis, AG1, are thanked for their technical assistance in producing the figures.

SECTION VII

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13. ABSTRACT

ESSA 2 and NIMBUS 2 APT daylight cloud photographs of the Western Pacific area (0-20N, 135-165E) from 13 through 30 May 1966 were manually converted into digitized cloud charts indicating cover and type. The charts were superimposed on operational surface and 250-mb analyses and used in combination with 24-hour isallobaric/isalloneph charts to revise the analyses to reflect satellite observations. The map series indicated the relationship between synoptic-scale cloud systems, primarily in and near the Equatorial Trough region of the Western Pacific, and low level pressure fields and upper level lateral divergence zones. The cloud systems tied to Equatorial Trough phenomena were found to be trackable from day to day. Rainfall appeared to correlate well with the cloud charts and, as a test, cloud and precipitation forecasts were made and verified for selected stations.

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